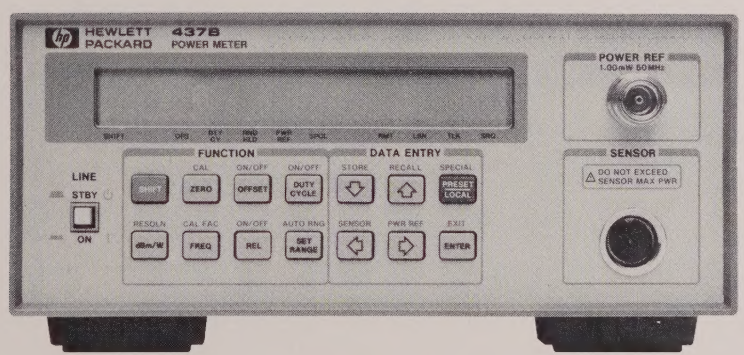
OPERATING MANUAL

HP 437B
POWER METER



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Instrument Serial Number

Manual Part Number

Manual Print Date

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OPERATING MANUAL

HP 437B
POWER METER

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2801A and above.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY THIS MANUAL in Section 1.

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1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

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CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

HP 437B

Herstellerbescheinigung

Hiermit wird bescheinigt, dass dieses Gerät/System in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkenstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Mess- und Testgeräte:

Werden Mess- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Messaufbauten verwendet, so ist vom Betreiber sicherzustellen, dass die Funk-Entstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's Declaration

This is to certify that this product meets the radio frequency interference requirements of Directive FTZ 1046/1984. The German Bundespost has been notified that this equipment was put into circulation and has been granted the right to check the product type for compliance with these requirements.

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements on open set-ups, the user must ensure that under these operating conditions, the radio frequency interference limits are met at the border of his premises.

Safety Considerations

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

Before Applying Power

Verify that the product is set to match the available line voltage and the correct fuse is installed.

Safety Earth Ground

An uninterruptable safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

Warning

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.) In addition, verify that a common ground exists between the unit under test and this instrument prior to energizing either unit.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the mains supply).

Servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

HP 437B

For continued protection against fire hazard, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay, etc.). Do not use repaired fuses or short circuited fuseholders.

Safety Symbols

Instruction manual symbol: The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (see Table of Contents for page references).

Indicates hazardous voltages.

Indicates earth (ground) terminal.

Warning

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

Caution

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

1 GENERAL INFORMATION

1-1. Description

The HP 437B Power Meter is a programmable single-channel average power meter. It measures power in the range of -70 to +44 dBm over the frequency range of 100 kHz to 50 GHz using the existing Hewlett-Packard 8480 series power sensors. A 1.00 mW 50 MHz power reference is available at the front panel for calibrating the meter to the power sensor.

The Power Meter displays power in the following modes: dBm, dB relative, watts, and percent relative. The resolution of the display can be set from the front panel. Three levels of display resolution are available; 1.0%, 0.1%, or 0.01% of full scale in linear mode (0.1, 0.01, and 0.001 dB in log mode). The DUTY CYCLE key provides a convenient peak power representation of the measured average power of a rectangular pulsed input signal.

The HP 437B has both manual and automatic ranging. In the AUTO RANGE mode the meter automatically selects the appropriate range for measuring the input signal. In the SET RANGE mode, any one of the five ranges can be selected by the user.

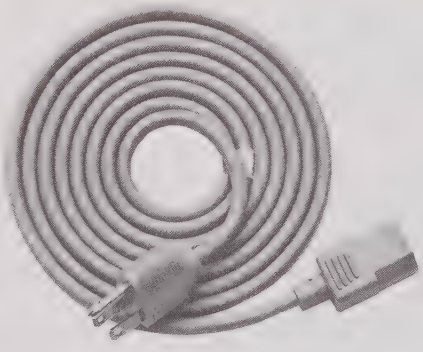
Zeroing, calibration, and offsets are capabilities of the meter that can be set either locally by the front panel keys or remotely over the Hewlett-Packard Interface Bus (HP-IB).

The SPECIAL key accesses special functions of the Power Meter. These special functions are: automatic or manual filter selection, setting upper and lower display limits, selecting the HP-IB address, entering frequency vs. calibration factor tables, invoking a series of internal self-tests, and initializing the instrument.

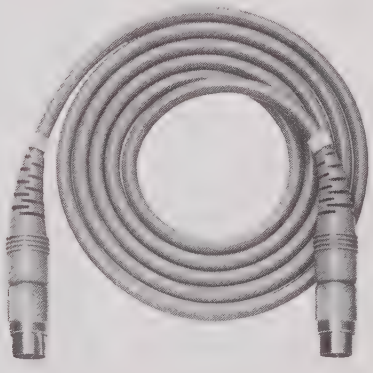
Memory capacity for saving up to ten front panel settings is built into the Power Meter and can be accessed by using the STORE and RECALL keys. The Power Meter also contains memory space for ten tables of sensor specific calibration factors. These tables are accessed using the SPECIAL key. This feature allows the user to make calibrated power measurements without the necessity of entering the calibration factor for each frequency.

The Power Meter also has a FREQ (frequency) key which allows entry of the frequency of the input signal. Entering a frequency causes the Power Meter to select a sensor-specific calibration factor from previously stored tables. A specific table of calibration factors is selected using the SENSOR key.

HP 437B



LINE POWER CABLE



POWER SENSOR CABLE

Figure 1-1. HP 437B Power Meter with Accessories Supplied.

1-2. Documentation

The HP 437B operating and service information consists of an Operating Manual and a Service Manual. These two volumes contain all the information required to install, operate, test, adjust, and service the HP 437B Power Meter. Figure 1-1 shows the Power Meter with all of its externally supplied accessories.

The Operating Manual, which is shipped with each instrument, has four sections:

Section 1, General Information
Section 2, Installation
Section 3, Operation
Section 4, Performance Tests

The Service Manual, which is shipped with the instrument as Option 915 or ordered separately, has four sections:

Section 5, Adjustments
Section 6, Replaceable Parts
Section 7, Manual Changes
Section 8, Service

Additional copies of the Operating Manual or the Service Manual can be ordered separately through your nearest Hewlett-Packard office. The part number is listed on the title page of this manual.

An introductory guide to the HP 437B is also available. This guide contains brief how-to-do-it descriptions of all the major functions of the Power Meter, as well as a table of error messages. The guide is available in six languages. The English guide is shipped with the instrument. The guide in other languages can be ordered separately or shipped with the instrument as an option. The part numbers and option numbers are listed below:

English Guide: 00437-90014
Japanese Guide: 00437-90019, Option 30
French Guide: 00437-90020, Option 31
German Guide: 00437-90021, Option 32
Italian Guide: 00437-90022, Option 33
Spanish Guide: 00437-90023, Option 34

1-3. Specifications

Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument may be tested. Supplemental characteristics are listed in Table 1-2a and b. Supplemental characteristics are not warranted specifications, but are typical characteristics included as additional information for the user.

1-4. Safety Considerations

This product is a Safety Class I instrument, that is, one provided with a protective earth terminal. The Power Meter and all related documentation should be reviewed for familiarization with safety markings and instructions before operation. Refer to the Safety Considerations page found at the beginning of this manual for a summary of the safety information. Safety information for installation, operation, and performance testing is found in appropriate places throughout this manual.

1-5. Instruments Covered by this Manual

Attached to the rear panel of the instrument is a serial number plate. The serial number is in the form: 0000A00000. The first four digits and the letter are the serial number prefix. The last five digits are the suffix. The prefix is the same for identical instruments; it changes only when a configuration change is made to the instrument. The suffix however, is assigned sequentially and is different for each instrument. The contents of this manual apply directly to instruments having the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-6. Manual Changes Supplement

An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the instrument is different from those documented in this manual. If manual changes are needed, the manual for this newer instrument is accompanied by a Manual Changes supplement. The supplement contains "change information" that explains how to adapt this manual to the newer instrument.

In addition to change information, the supplement may contain information for correcting errors in the manual. To keep the manual as current and as accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement is identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

1-7. Options

1-8. Electrical Options

Option 002 provides the additional capability of having a power input connector on the rear panel in parallel with the front panel input. (Only one power input can be used at a time.) The 50 MHz power reference on the Option 002 is located on the front panel.

Option 003 provides power input connectors on the front and rear panels of the Power Meter. (Only one power input can be used at a time.) In addition, the 50 MHz power reference is located on the rear panel.

Option 004 deletes the HP 11730A sensor cable normally supplied with the power meter.

1-9. Mechanical Options

Option 401 adds one handle to the side of the Power Meter.

1-10. Hewlett-Packard Interface Bus

The Power Meter is compatible with HP-IB to the extent indicated by the following codes: SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT1, and C0. The Power Meter interfaces with HP-IB via tri-state circuitry. An explanation of the compatibility code can be found in IEEE Standard 488 (1978), "IEEE Standard Digital Interface for Programmable Instrumentation" or the identical ANSI Standard MC1.1. For more detailed information relating to programmable control of the Power Meter, refer to Remote Operation, Hewlett-Packard Interface Bus in Section 3 of this manual.

1-11. Accessories Supplied

The accessories supplied with the Power Meter are shown in Figure 1-1.

The line power cable is supplied in one of several configurations, depending on the destination of the original shipment. Refer to Power Cables in Section 2 of this manual.

One power sensor cable, HP part number 11730A, is supplied with the Power Meter.

1-12. Accessories Available

Rack Mounting Kits

The rack mounting kits contain all the necessary hardware to allow the Power Meter to be solidly mounted into an equipment rack.

Rack mounting one meter. Order HP part number 5061-9672. This kit includes one rack flange and one extension adapter.

Rack mounting two meters. Order the following: HP part number 5061-9674 (two rack flanges) and HP part number 5061-9694 (cabinet locking hardware).

1-13. Cables

Power Sensor cables of various lengths are available. The model numbers and lengths are listed below.

HP 11730A 1.5m (5 ft)
HP 11730B 3.0m (10 ft)
HP 11730C 6.1m (20 ft)
HP 11730D 15.2m (50 ft)
HP 11730E 30.5m (100 ft)
HP 11730F 61.0m (200 ft)

1-14. Recommended Test Equipment

Table 1-3 lists the test equipment recommended for use in testing, adjusting and servicing the Power Meter. The Critical Specifications column describes the essential requirements for each piece of test equipment. Other equipment can be substituted if it meets or exceeds these critical specifications.

The Recommended Model column may suggest more than one model. The first model shown is usually the least expensive, single-purpose model. Alternate models are suggested for additional features that would make them a better choice in some applications.

Table 1-1. Specifications

Electrical Characteristics	Performance Limits	Conditions
Frequency range	100 kHz to 50 GHz	Sensor dependent
Power range	-70 dBm to +44 dBm (100 pW to 25W)	Sensor dependent
Dynamic range	50 dB total range	5 ranges of 10 dB steps for 50 dB total
Display units	Watts or dBm Percent or dB	Absolute measurement mode Relative measurement mode
Resolution Low Mid High	 1.0% full scale (0.1 dB) 0.1% full scale (0.01 dB) 0.01% full scale (0.001 dB)	
Accuracy: Instrumentation, includes sensor linearity[1]	**Absolute mode:** ±0.02 dB or ±0.5% **Relative mode:** ±0.02 dB or ±0.5% ±0.04 dB or ±1%	 Within measurement range. Outside measurement range.
Zero set (digital (settability of zero)	±0.5% full scale	Most sensitive range. Decrease percentage by a factor of 10 for each higher range ± one count.
EMI	Radiated and Conducted Emissions and Radiated and Conducted Susceptibility are within the requirements of RE02, CE03, RS01/03 and CS01/02 called out in MIL-STD-461C, and within the requirements of VDE 0871 and CISPR Publication 11.	

[1] When operating in Ranges 4 or 5, add the corresponding sensor power linearity percentage.

Table 1-1. Specifications (Cont.)

Electrical Characteristics	Performance Limits	Conditions
Power reference	1.00 mW	Internal 50 MHz oscillator factory set to ±0.7% traceable to National Bureau of Standards.
Power reference accuracy	±1.2% ±0.9%	Worst case RSS for one year.
Operating Temperature Range	0° C to 55° C	
Power Requirements Line Voltage	100, 120, 220, or 240 Vac, +5% to -10%	
Line Frequency	48 to 66 Hz 360 to 440 Hz	All specified line voltages may be used. Limited to line voltages of 100 or 120 Vac.
Power Dissipation	<10 VA (8 watts max)	
Remote Operation	HP-IB	All functions except LINE switch, HP-IB address, self test, SPECIAL status, and INIT (initialize)
Compatibility	HP-IB interface	SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT1, C0
Memory	Non-volatile	
Operating and non-operating environment	Temperature, humidity, shock, and vibration type tested to MIL-T-28800B Class V requirements.	
Safety	Meets requirements of IEC 348	
Net weight Shipping weight	2.6 kg (5.9 lbs.) 4.5 kg (10 lbs.)	
Dimensions: Height x Width x Depth	88 mm H x 212 mm W x 273 mm D. (3.46 H x 8.35 W x 10.75 inches D).	EIA and IEC racking standards: 3.5 H x .5 MW x 11 D

Table 1-2a. Supplemental Characteristics

ZERO DRIFT OF SENSORS As a % of full scale, 1 hour, at constant temperature after 24 hours warmup. Sensors: **HP 8481A, 8481B, 8481H, 8482A, 8482B, 8482H, 8483A, 8485A, R8486A, Q8486A:**	±0.1% of full scale on range 1.
Sensors: **HP 8484A:**	±2.0% of full scale on range 1.
Decrease percentage by a factor of 10 for each higher range.	
MEASUREMENT SPEED Over HP-IB and free running trigger.	20 readings per second.
POWER REFERENCE Frequency SWR Connector	 50 MHz nominal 1.05 maximum Type N female
RECORDER OUTPUT	0-1 volt analog without digital filtering or calibration factor correction. 1 kΩ output impedance, BNC connector.
METER ADJUSTMENTS:	
CAL FAC	Key pad entry or programmable. Sets calibration factor for the meter. Overrides current value. Range: 1-150% in 0.1% increments.
ZERO	Key pad entry or programmable. Zeros all 5 ranges, reference oscillator switched off during zeroing.
CAL	Key pad entry or programmable. Calibrates meter using internal or external source. Reference Cal Factor settable from 50 to 150%.
OFFSET	Key pad entry or programmable. Displayed reading differs from measured reading by the OFFSET value. Range: -99.99 to +99.99 dB in 0.01 dB increments.

Table 1-2a. Supplemental Characteristics (Cont.)

REL	Key pad entry or programmable. Displays all successive measurements relative to the last displayed value when activated.
FREQ	Key pad entry or programmable. Entered frequency is used to interpolate the calibration factors table. Range: 0.0001 to 999.9999 GHz.
RESOLN	Key pad entry or programmable. Selects display resolution. Range: 1.0%, 0.1%, or 0.001% of full scale (linear mode). 0.1, 0.01, or 0.001 dB (log mode).
PWR REF	Key pad entry or programmable. Switches 50 MHz reference oscillator on or off.
DUTY CYCLE	Key pad entry or programmable. Allows entry of duty cycle to measure pulse power of pulsed input signal. Range: .001% to 99.999%.

Table 1-2b. Supplemental Characteristics

METER NOISE

As a % of full scale, with constant temperature, range 1, measured over a one minute interval, and two standard deviations. Decrease noise by a factor of 10 for each higher range for all sensors and all filters.

Sensors:
HP 8481A, 8481B, 8481H, 8482A, 8482B, 8482H, 8483A, 8485A, R8486A, Q8486A:

Number of Averages	Noise (%)
1	6.0
2	2.4
4	1.8
8	0.9
16	0.7
32	0.5
64	0.4
128	0.3
256	0.2
512	0.15

Sensors: HP 8484A:
Multiply noise levels by 4 for all filters.

SETTLING TIME

0 to 99% settled readings over the bus. Auto filter, range hold, 10 dB decreasing power step.

Range	Settling Time
1	<7.0 s
2	<1.0 s
3	<150 ms
4-5	<100 ms

Manual filter, range hold, 10 dB decreasing power step.

Number of Averages	Response Time(s)
1	0.10
2	0.15
4	0.25
8	1.0
16	1.4
32	2.2
64	3.7
128	6.9
256	14.0
512	27.0

Table 1-3. Recommended Test Equipment

Instrument	Critical Specifications	Recommended Model	Use*
Digital Voltmeter	Range 0 to 20 Vdc	HP 3456A	P, A, T
Oscilloscope	>200 MHz bandwidth	HP 54201A	T
Range Calibrator	Calibration uncertainty ±0.25%		P, A, T
Frequency Counter	Range: 10 Hz to 50 MHz Resolution: 1 Hz	HP 5328A Option 031	P, A, T
Power Meter	Range: 1 mW Transfer Accuracy: 0.2% (Input to output)	HP 432A	P, A, T
Thermistor Mount	SWR: 1.05 at 50 MHz Accuracy: ±0.5% at 50 MHz	HP 478A-H75[1] or HP 478A-H76[2]	P, A

*P=Performance Tests, A=Adjustments, T=Troubleshooting.
[1] Calibrated at the National Bureau of Standards (NBS) for this accuracy.
[2] HP standards lab calibration to ±0.58% at 50 MHz (traceable to NBS).

Table 1-4. Service Accessories

Accessory*	Specification	Suggested Model
Open-end Wrench (SMC Connectors)	1/4-inch	Utica Tool Co.**, Open End Standard, Model No. OP82, 1/4-inch
Foam Pad	Conductive polyurethane foam, 12x12x0.25 inches	HP 4208-0094

*Refer to Section 8, Service, for applications.
** Utica Tool Company, Inc., Orangeburg, SC 29115 or the nearest Utica Tool Company distributor.

2 INSTALLATION

2-1. Introduction

This section provides the information needed to install the Power Meter. Included is information pertinent to initial inspection, power requirements, line voltage selection, power cables, interconnection, environment, instrument mounting, storage, and shipment. In addition, this section contains the procedures for selecting the impedance of the instrument inputs and setting the HP-IB address.

2-2. Initial Inspection

Warning

To avoid hazardous electrical shock, do not turn on the instrument when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, display).

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. Procedures for checking electrical performance are given in Section 4. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of unusual stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

2-3. Preparation for Use

Warning

To avoid the possibility of hazardous electrical shock, do not operate this instrument at line voltages greater than 126.5 Vac with line frequencies greater than 66 Hz. Leakage currents at these line settings may exceed 3.5 mA.

This is a Safety Class I product (that is, it is provided with a protective earth terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals through the power cable or supplied power cable set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an external autotransformer, make sure the autotransformer's common terminal is connected to neutral (that is, the grounded side of the line (Mains) supply.)

2-4. Installation Checklist

Before plugging the Power Meter into the line (Mains) voltage, ensure the following steps are taken:

1. Check the line (Mains) voltage to ensure compatibility with the Power Meter requirements. (See paragraph 2-5, Power Requirements).

2. Check the line voltage switches on the Power Meter's rear panel to ensure proper selection for the line (Mains) voltage. (See paragraph 2-6, Line Voltage and Fuse Selection).

3. Ensure that the fuse rating is appropriate for the line voltage used. Fuse ratings are listed in Table 2-1.

4. Ensure that the power cable to be used is the required type. (See paragraph 2-7, Power Cables).

Caution

BEFORE PLUGGING THIS INSTRUMENT into the line (Mains) voltage, ensure that the correct voltage and fuse have been selected.

5. Plug in the power cable.

2-5. Power Requirements

Warning

To avoid the possibility of hazardous electrical shock, do not operate this instrument at line voltages greater than 126.5 Vac with line frequencies greater than 66 Hz. Leakage currents at these settings may exceed 3.5 mA.

The Power Meter requires a power source of 100, 120, 220, or 240 Vac, +5% to -10%, 48 to 66 Hz single phase. The Power Meter has the additional capability of operating with line frequencies of 360 to 440 Hz. However, operation at line frequencies greater than 66 Hz is limited to a line voltage of 90 to 126 Vac. Power consumption is <10 VA maximum.

2-6. Line Voltage and Fuse Selection

Caution

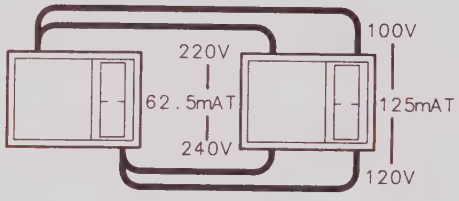
Before plugging this instrument into the Mains (line) voltage, ensure that the correct operating voltage and fuse have been selected.

Verify that the line voltage selection switches and the fuse are matched to the power source. See Figure 2-1, Line Voltage and Fuse Selection.

Table 2-1. Fuse Ratings and Part Numbers

Line Voltage	Rating	Part Number
100/120V	125 maT*	2110-0318
220/240V	62.5 maT*	2110-0311

* Time Delay (slow-blow) fuse.



SELECTION OF OPERATING VOLTAGE

1. Using a blade-type screwdriver, position the rear-panel line voltage select switches for desired line (Mains) voltage.

2. Select and install the proper line fuse. Table 2-1 lists the ratings and HP part numbers for the replaceable fuses.

Figure 2-1. Line Voltage and Fuse Selection

2-7. Power Cables

Warning

BEFORE CONNECTING THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the line (Mains) power cable. The line plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two conductor outlet is not sufficient protection.

This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument chassis. The type of power cable plug shipped with each instrument depends on the country of destination. See Figure 2-2, Power Cable and Line (Mains) Plug Part Numbers, for the part numbers of these power cables. Cables are available in different lengths and some with right angle plugs to the instrument. Check with your nearest HP service center for descriptions and part numbers for these cables.

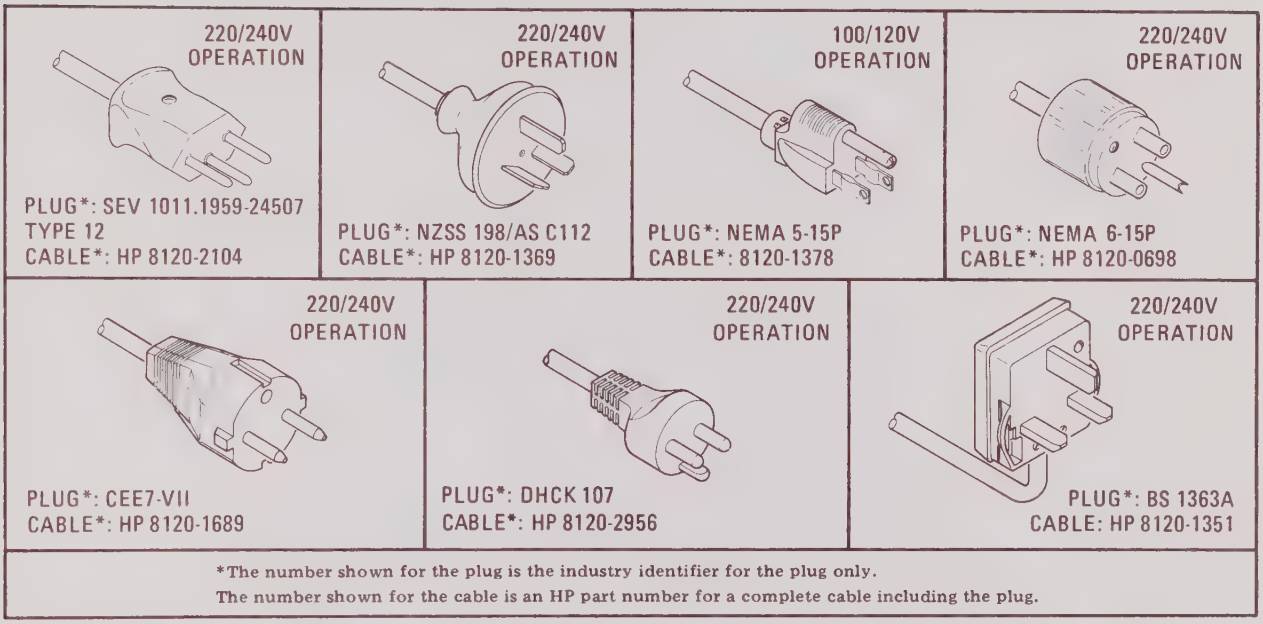


Figure 2-2. Power Cable and Line (Mains) Plug Part Numbers

2-8. HP-IB Address Selection and Configuring

HP-IB Address Selection. The HP-IB address is selectable from the front panel.

When shipped from the factory the address of the instrument is 13. HP-IB addresses from 00 to 30 as well as 40 (listen only) and 50 (talk only) can be used. A list of allowable addresses is given in Table 2-2.

Table 2-2. Allowable HP-IB Addresses

ASCII Address Codes		Decimal Equivalents[1]
LISTEN	TALK	
SP	@	00
!	A	01
"	B	02
-	C	03
$	D	04
%	E	05
&	F	06
'	G	07
(	H	08
)	I	09
*	J	10
+	K	11
,	L	12
-	M	13[2]
.	N	14
/	O	15
0	P	16
1	Q	17
2	R	18
3	S	19
4	T	20
5	U	21
6	V	22
7	W	23
8	X	24
9	Y	25
:	Z	26
;	[	27
<	\	28
=	]	29
>		30

[1] Decimal values are equivalent to the last five bits of both talk and listen addresses.

[2] Decimal 13 is the factory set HP 437B addresses.

Use the following procedure to set the HP-IB address:

1. Press the SPECIAL key (SHIFTed PRESET/LOCAL).
2. Press [▲] or [▼] until the display reads "4 HP-IB ADRS".
3. Press the ENTER key. The display will read "ADDRESS 13"
4. Press [▲], [▼], [◀], or [▶] until the desired HP-IB address is displayed.
5. Press the ENTER key.

2-9. Interconnections

The connection from the Power Meter to the power sensor is made through HP 11730 series sensor cables.

Interconnection data for the Hewlett-Packard Interface Bus is provided in Figure 2-3, Hewlett-Packard Interface Bus Connection.

2-10. Mating Connectors

HP-IB Interface Connector. The HP-IB mating connector is shown in Figure 2-3, Hewlett-Packard Interface Bus Connection. Note that the two securing screws are metric.

Coaxial Connectors. RECORDER OUTPUT on the rear panel requires a 50Ω BNC male mating connector that is compatible with the specifications of US MIL-C-39012.

Type N Connectors. The POWER REF output on the front panel and on the rear panel (Option 002 only) require 50Ω type N male mating connectors. These connectors must be compatible with the specifications of US MIL-C-39012.

2-11. Operating Environment

The operating environment is specified to be within the following limitations:

Temperature .....0°C to +55°C
Humidity..... <95% relative
Altitude.....<4570 metres (15 000 feet)

2-12. Bench Operation

The instrument cabinet has plastic feet and fold-away tilt stands for convenience in bench operation. The plastic feet are designed to ensure self-aligning of instruments when stacked. The tilt stands raise the front of the instrument for easier viewing of the front panel.

2-13. Rack Mounting

The Power Meter may be rack mounted using Hewlett-Packard sub-module cabinets. If it is desired to rack mount one Power Meter by itself, order half-module kit, HP Part Number 5061-9672.

If it is desired to rack mount two Power Meters or another HP product with the same physical dimensions side by side, order the following items:

1. Lock Link Kit, HP Part Number 5061-9694
2. Rack Mounting Flange Kit, HP Part Number 5061-9676

In addition to the rack mounting hardware, a front handle assembly (two handles provided) is also available for the Power Meter. Order front handle kit Option 907, HP Part Number 5061-9688.

Rack mounting information is provided with the rack mounting kits. If the kits were not ordered with the instrument as options, they may be ordered through the nearest Hewlett-Packard office. Refer to Mechanical Options in Section I for information regarding rack mounting kits.

2-14. Storage and Shipment

2-15. Environment

The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature ..... -55°C to +75°C
Humidity ..... <95% relative
Altitude ..... <15 300 metres (50 000 feet)

2-16. Packaging

Tagging for Service. If the instrument is being returned to Hewlett-Packard for service, please complete one of the blue repair tags located at the end of this manual and attach it to the instrument.

To minimize repair time, be as specific as possible when describing the failure. Keep the following two items in mind when describing the failure:

1. Describe what makes you think the instrument is failing. An example might be "Power Meter displays NO SENSOR when a power sensor is connected to the input port".

2. If the failure only occurs under certain conditions, explain how to duplicate the failure. An example might be "Power Meter will not make measurements in ranges 4 and 5."

Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. Mark the container "FRAGILE" to encourage careful handling. In any correspondence, refer to the instrument by model number and full serial number.

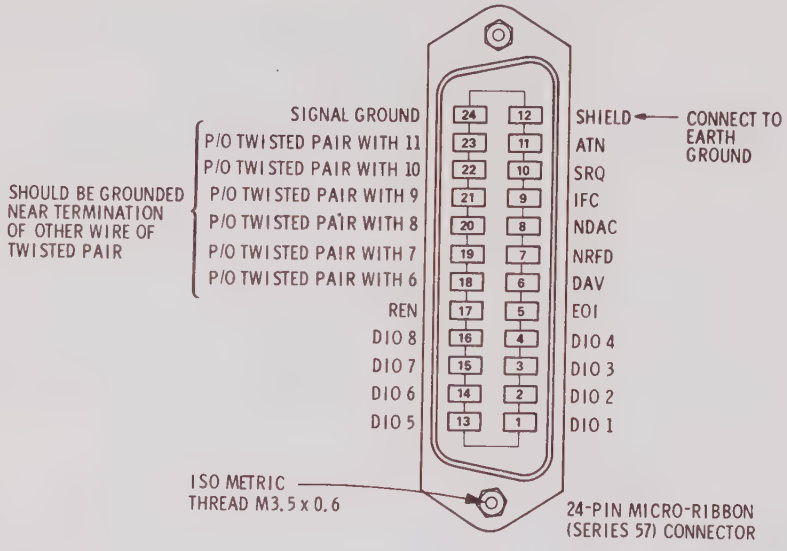
Other Packaging. The following general instructions should be used for repackaging with commercially available materials.

1. Wrap the instrument in heavy paper or plastic. If shipping to a Hewlett-Packard office or service center, complete one of the blue tags mentioned above and attach it to the instrument.

2. Use a strong shipping container. A double-wall carton made of 2.4 MPa(350 psi) test material is adequate.
3. Use enough shock-absorbing material (75 to 100 mm layer; 3 to 4 inches) around all sides of the instrument to provide a firm cushion and prevent movement in the container. Protect the front panel with an appropriate type of cushioning material to prevent damage during shipment.

4. Seal the shipping container securely.

5. Mark the shipping container "FRAGILE" to encourage careful handling.



Logic Levels

The Hewlett-Packard Interface Bus Logic Levels are TTL compatible, i.e., the true (1) state is 0.0 Vdc to +0.4 Vdc and the false (0) state is +2.5 Vdc to +5.0 Vdc.

Programming and Output Data Format

Refer to Section 3, Operation.

Mating Connector

HP 1251-0293; Amphenol 57-30240.

Mating Cables Available

HP 10833A, 1 metre (3.3 ft), HP 10833B, 2 metres (6.6 ft)
HP 10833C 4 metres (13.2 ft), HP 10833D, 0.5 metres (1.6 ft)

Cabling Restrictions

1. A Hewlett-Packard Interface Bus system may contain no more than 2 metres (6 ft) of connecting cable per instrument.
2. The maximum accumulative length of connecting cable for any Hewlett-Packard Interface Bus system is 20.0 metres (65.6 ft).

Figure 2-3. Hewlett-Packard Interface Bus Connection

3 OPERATION

3-1. Introduction

This section provides operating information for the Power Meter. Included in this section are general and detailed operating instructions, descriptions of the front and rear panel, local and remote operator's instructions, and operator's maintenance procedures.

3-2. Operating Characteristics

Table 3-1 briefly summarizes the major operating characteristics of the Power Meter. This table is not intended to be an in-depth listing of all operations and ranges but gives an idea of the instruments capabilities. For more information on the Power Meter's capabilities refer to Table 1-1, Specifications and Table 1-2, Supplemental Characteristics. For information on HP-IB capabilities, refer to the summary contained in Table 3-3, HP-IB Message Reference Table.

3-3. Local Operation

Initial Turn-On Information. Instructions relating to the Power Meter's turn-on procedure are presented to acquaint the user with the general operation of the instrument.

Information covering front panel operation of the Power Meter is given in the sections described below. To rapidly learn the operation of the instrument, begin with with Major Operating Characteristics and Operator's Checks.

Panel Features. Front and rear panel features are described in Figures 3-1 and 3-2. In the upper left corner of the keyboard is a blue SHIFT key. This key accesses SHIFTed functions of the keys. These SHIFTed functions are described by the blue labels above each key. For more information about the SHIFTed functions of the keys, see the Detailed Operating Instructions in this section.

Simplified Operating Instructions. The instructions located on the foldout provide a quick introduction to front panel operation of the Power Meter. These instructions are designed to rapidly acquaint the new user with basic operating procedures and therefore are not an exhaustive listing on all Power Meter functions.

Detailed Operating Instructions. The detailed operating instructions provide the operating reference information for the Power Meter user.

3-4. Remote Operation

The Power Meter is capable of remote operation via the Hewlett-Packard Interface Bus (HP-IB). Instructions pertinent to HP-IB operation cover considerations and instructions specific to remote operation including capabilities, addressing, input and output formats, the status byte, and service requests. At the end of the discussion is a complete summary of all codes.

3-5. Operator's Checks

Operator's Checks are procedures designed to verify the proper operation of the Power Meter's main capabilities. Two procedures are provided as described below.

Basic Front Panel Checks. This procedure requires power sensors, cables, and a power splitter. It assures the operator that most front panel controlled features are being properly executed by the Power Meter.

HP-IB Functional Checks. These procedures require an HP-IB compatible computing controller, an HP-IB interface, and connecting cable. The procedures check the applicable bus messages summarized in Table 3-3. The HP-IB Checks assume that front panel operation has been verified by performing the Basic Front Panel Checks.

3-6. Operator's Maintenance

Warning

For continued protection against fire hazard, replace the line fuse with a 250V fuse of the same rating only. Do not use repaired fuses or short-circuited fuseholders.

Operator's maintenance consists of replacing defective fuses. The primary power fuse is located within the Line Power Module Assembly. Refer to Figure 2-1 for instructions on how to change the fuse.

If the instrument does not operate properly and is being returned to Hewlett-Packard for service, please complete one of the blue tags located at the end of this manual and attach it to the instrument. Refer to Section 2 for packaging instructions.

Table 3-1. Major Operating Characteristics

POWER RANGE (Sensor Dependent)	-70 dBm to +44 dBm **POWER SENSOR — RANGE** HP 8481B — 0 to +44 dBm (1 mW to 25 W) HP 8482B — 0 to +44 dBm (1 mW to 25 W) HP 8481H — -10 to +35 dBm (100 μW to 3 W) HP 8482H — -10 to +35 dBm (100 μW to 3 W) HP 8481A — -30 to +20 dBm (1 μW to 100 mW) HP 8482A — -30 to +20 dBm (1 μW to 100 mW) HP 8485A — -30 to +20 dBm (1 μW to 100 mW) HP 8483A 75 Ohm[1] — -30 to +20 dBm (1 μW to 100 mW) HP R8486A — -30 to +20 dBm (1 μW to 100 mW) HP Q8486A — -30 to +20 dBm (1 μW to 100 mW) HP 8484A — -70 to -20 dBm (100 pW to 10 μW)
FREQUENCY RANGE (Sensor Dependent)	100 kHz to 50.0 GHz **POWER SENSOR — RANGE** HP 8483A 75 Ohm — 100 kHz - 2 GHz HP 8482A — 100 kHz - 4.2 GHz HP 8482B — 100 kHz - 4.2 GHz HP 8482H — 100 kHz - 4.2 GHz HP 8481A — 10 MHz - 18 GHz HP 8481B — 10 MHz - 18 GHz HP 8481H — 10 MHz - 18 GHz HP 8484A — 10 MHz - 18 GHz HP 8485A — 50 MHz - 26.5 GHz HP R8486A — 26.5 GHz - 40 GHz HP Q8486A — 33 GHz - 50 GHz
ZEROING	Calibration of the Power Meter to power sensor sensitivity

Table 3-1. Major Operating Characteristics (Cont.)

CALIBRATION FACTOR	Compensation for mismatch and effective efficiency
POWER REFERENCE	1 mW at 50 MHz
POWER DISPLAY	dBm, dB Relative, Watts, and % Relative
OFFSET	Compensation for gains or losses in test system
DIGITAL FILTERING	Greater accuracy is achieved by averaging together a user-selectable number of readings.
MEMORY	10 registers for store and recall of front panel information. An eleventh register is used for recall only of current front panel information.
FREQ	Allows entry of input frequency for automatic calibration factor selection.
DUTY CYCLE	Allows entry of input signal's duty cycle for automatic calculation of pulse power.
SENSOR	Allows entry of power sensor's ID number for selection of a table of sensor-specific calibration factors.
REL	Allows power measurements relative to another power level.

[1] When using an older 8483A that specifies adjusting to 0.96 mW, the following procedure should be used:

1. Set REF CF to 0.96 times the Ref Cal Factor on the label.

2. The Power Meter will automatically adjust to 1.000 mW. Note that the cal factor value for 50 MHz power measurements should be read from the plotted data on the sensor body. No special procedure is necessary for these measurements.

FRONT PANEL FEATURES

OFFSET. Causes the Power Meter to enter the offset mode. The user can enter an offset value to compensate for signal gain or loss.

STORE. Causes the Power Meter to store the current instrument configuration in one of the ten storage registers.

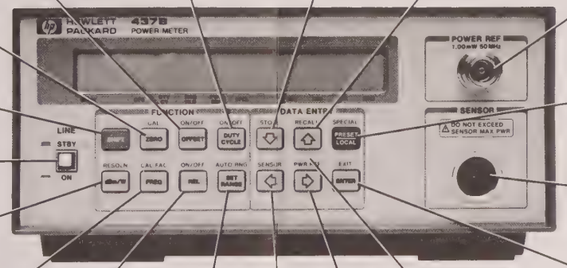
ZERO. Initiates a routine that zeroes the power sensor on all ranges.

DUTY CYCLE. Allows entry of the duty cycle of a pulsed input signal. This causes the Power Meter to display pulse power.

RECALL. Causes the Power Meter to recall previously stored instrument configurations from one of eleven storage registers.

POWER REF. Provides a 50 MHz 1 mW signal for calibrating the power sensor to the Meter. The connector is type N with 50 ohms impedance.

CAL. Allows entry of the power sensor's REF CAL FACTOR, then calibrates the power sensor to the 1 mW 50 MHz reference oscillator.



SHIFT. Blue SHIFT key allows access to secondary function of certain keys. Keys containing shift functions are labeled with that function in blue.

PRESET/LOCAL. When in local mode, sets the Power Meter to default conditions. When in remote (HP-IB) mode, returns the Power Meter to local mode.

SPECIAL. Accesses the SPECIAL group of operations. These operations allow the user to define specific measurement parameters.

LINE. Primary power to the Power Meter is switched on and off.

Input Connector. Female 12 contact connector.

dBm/W. Causes the Power Meter to display measurements in either dBm or Watts.

RESOLN. Allows the user to adjust the resolution of the Power Meter's display.

ENTER. Used to terminate numeric data entered into the Power Meter's front panel. Also accesses various levels of data entry of the SPECIAL key.

FREQ. Allows entry of the frequency of the input signal. This causes the Power Meter to select a sensor-specific calibration factor.

Arrow keys. Used to modify numeric data that is to be entered into the Power Meter.

EXIT. Discontinues access to the SPECIAL operations.

CAL FAC. Allows entry of a calibration factor to compensate for mismatch losses and effective efficiency over the frequency range of the power sensor.

REL. Causes any measurement to be compared in dB or percent (%) to a reference value.

PWR REF. Turns the POWER REF (50 MHz 1 mW reference oscillator) on and off.

SET RANGE. Allows the user to manually select a power range for the input signal.

AUTO RNG. Automatically selects the correct range for the input signal.

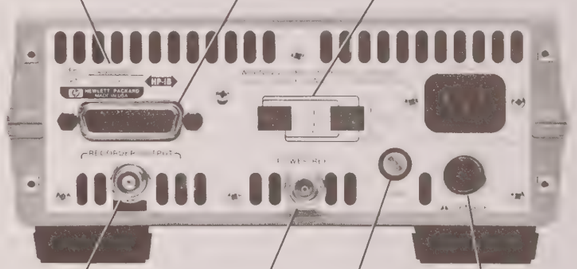
SENSOR. Used to select the ID number for the power sensor that is being used. This function allows the FREQ key to access the proper table of calibration factors for the indicated power sensor.

Figure 3-1. Simplified Front Panel Features

HP-IB Connector. Female connector with 24 contacts used to connect the Power Meter to Hewlett-Packard Interface Bus (HP-IB) for remote operation.

Serial Number Plate. First four digits and letter constitute the prefix which defines the instrument configuration. The last five digits form a sequential suffix that is unique to each instrument. The plate also indicates any options supplied with the instrument.

Voltage Selection Switches. Permits Power Meter operation using 100, 120, 220, or 240 Vac.



Recorder Output. BNC connector with an analog 0 to 1 volt signal that is proportional to the power level measured by the Meter. Output impedance is 1k ohm.

Option 002 SENSOR Connector. Option 002 rear panel input is through a 12 contact connector. This input is in parallel with the front SENSOR connector.

Fuse. 125 mA 250V slo-blo for 100/120 Vac operation and 62.5 mA 250V slo-blo for 220/240 Vac operation. Ordering information is presented in Section 2, Installation.

POWER REF. Option 003 rear panel 1 mW 50 MHz reference oscillator output. Output connector is 50 ohm type N.

Figure 3-2. Rear Panel Features

3-7. Turn-on Instructions

Warning

Before the instrument is switched on, all protective earth terminals, extension cords, autotransformers and devices connected to it should be connected to a protective earth grounded socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

Only 250V slow blow fuses with the required rated current should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.

Turn-On Procedure. If the Power Meter is already plugged in, press the LINE switch to ON.

If the power cable is not plugged in, follow these instructions.

On the rear panel:

1. Check the line voltage switch for correct voltage selection.
2. Check that the fuse rating is appropriate for the line voltage used (see Figure 2-1). Fuse ratings are printed on the rear panel.
3. Plug in the power cable.
4. On the front panel, press the LINE switch to ON.

Note

The Power Meter turns on to the same control settings it had before line power was removed. An exception to this is that it always turns on in the local mode. In addition some HP-IB default conditions are enabled.

When the Power Meter is turned on, it will execute a power up sequence which will be followed by an automatic RECALL 0. The power up sequence will run some self test routines to verify the operation the Power Meter. If any self test failures occur an error message will be reported to the user on the front panel display. If, for some reason, RAM content is lost, this error will be reported and all storage registers will be initialized to put the Power Meter into the PRESET state. Storage location 0 is also set to the PRESET state when a RAM error occurs. This means the Power Meter will be in the PRESET state when it begins operation.

An internal battery is used to retain data in RAM when the LINE cord is disconnected. The data restores the last control setup that was saved in storage location zero and the other ten storage registers.

3-8. Error Messages

Power up error message numbers as well as other error messages displayed on the front panel are listed and explained in Table 3-8 Error Messages. As an example, if a ROM or RAM failure occurs, the Power Meter will display an error code number in the range of 61 through 66 depending on the location in memory that has a problem.

3-9. Power Reference and Calibration

A POWER REF of 1.00 mW at 50 MHz is available at the front panel for calibrating the Power Meter to the sensor. The internal power reference is a 1 mW (0 dBm) 50 MHz oscillator that is factory set to ±0.7% and traceable to the National Bureau of Standards.

The Power Meter can be calibrated to the power sensor with the following procedure:

1. Connect the power sensor to the POWER REF connector.
2. Press the ZERO key. (Wait for the zeroing routine to finish).
3. Press the CAL (SHIFTed ZERO) key.
4. Key the REF CAL FACTOR of the power sensor into the Power Meter.
5. Press the ENTER key. The Power Meter will display "CAL*****".
6. When the "CAL*****" display disappears, calibration is finished.

For more information about the zeroing and calibration routines, see "ZERO" and "CAL" in the Detailed Operating Instructions in this section.

3-10. Simplified Operation

Preset

PRESET is used to set the Power Meter to known conditions. The PRESET conditions are shown in the following table.

Parameter	Condition
FREQ	50 MHz
RESOLN	0.01 dB
DUTY CYCLE	1.000%, Off
REL	0.0 dB, Off
OFFSET	0.00 dB, Off
PWR REF (Reference Oscillator)	Off
Range	AUTO
dBm/W	dBm
Low Limit	-90.000 dB
High Limit	+90.000 dB
Limit Checking	Off

1. Press the PRESET/LOCAL key.

Zero

Zero is used to adjust the Power Meter's internal circuitry for a zero power indication when no power is applied to the sensor. Pressing the ZERO key automatically zeroes all five of the Power Meter's ranges.

1. Disconnect the power sensor from any sources of input power.
2. Press the ZERO key. The Power Meter will display "ZEROING: *****".

Note

Zeroing will take 5-20 seconds.

3. When the "ZEROING: *****" display disappears, zeroing is finished.

Calibration

The CAL key is used to calibrate the Power Meter and any compatible power sensor to a known reference.

1. Connect the power sensor to the POWER REF connector in the upper right corner of the power meter.
2. Press the CAL key (SHIFTed ZERO).
3. The Power Meter will display the current reference calibration factor with one blinking digit.
4. Locate the REF CAL FACTOR (sometimes labeled "REF CF") on the power sensor.
5. Modify the blinking digit (see below) on the power meter's display (if necessary) until the sensor's REF CAL FACTOR is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
6. Press the ENTER key.
7. The Power Meter will display "CAL *****" for a few seconds. When the "CAL *****" display disappears, the calibration is finished.

Calibration Factor

The CAL FAC key is used to enter a calibration factor that will compensate for mismatch losses and effective efficiency of the power sensor.

Note

For greater convenience, up to ten tables of sensor-specific calibration factors can be stored in the Power Meter. These calibration factors can be accessed during a measurement using the SENSOR and FREQ keys. For more information about storing calibration factors, see "SENSOR DATA" in the Detailed Operating Instructions in the HP 473B Operating Manual.

1. Press the CAL FAC (SHIFTed FREQ) key. The Power Meter will display the current calibration factor with one of the digits blinking.
2. Examine the calibration factor table on the power sensor to determine the calibration factor necessary for the input frequency.
3. Modify the digits (see below) until the desired calibration factor is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
4. Press the ENTER key.

Power Measurement

Caution

Ensure that the output of the power source doesn't exceed the limits of the power sensor. Damage to the power sensor or Power Meter could result.

1. Connect the power sensor to the output of the power source to be measured.
2. Select the measurement mode (dBm or watts) using the dBm/W key.
3. If the input power's frequency has changed, ensure that the correct sensor calibration factor is being used. (The Power Meter's calibration factor can be checked by pressing the CAL FAC key).
4. The power output of the power source will be shown on the Power Meter's display.

Note

Zeroing and calibration of the Power Meter is recommended:

a. When a 5°C change in temperature occurs.
b. Whenever the power sensor is changed.
c. Every 24 hours.

Other Features

Major Features Keystroke Summary

Feature	Press These Keys
Automatic Range selection. Power Meter automatically selects the optimum power range for the input power.	SHIFT AUTO RNG
Selecting a specific range. User can select a power range to minimize range-to-range discrepancies.	SHIFT SET RANGE [▲] or [▼] to modify the blinking digit ENTER

Major Features Keystroke Summary (Cont.)

Feature	Press These Keys
Measuring pulsed signals. Enter duty cycle of the input signal for a peak power representation of the measured average power. (Pulse must be rectangular)	DUTY CYCLE ▲ or ▼ to modify the blinking digit ◀ or ▶ to move to other digits ENTER ENTER
Returning to Local mode (from HP-IB)	PRESET/LOCAL
Adjusting for offsets Changes display to reflect power before a known external gain or loss.	OFFSET ▲ or ▼ to modify the blinking digit ◀ or ▶ to move to other digits. ENTER
Power Reference on and off	SHIFT PWR REF
Entering a frequency. The user can select a pre-stored sensor-specific calibration factor by entering the measured signal's frequency via the FREQ key.	FREQ ▲ or ▼ to modify the blinking digit ◀ or ▶ to move to other digits ENTER
Storing and Recalling front panel settings. (Ten available storage registers)	To store a front panel setup: SHIFT STORE ▲ or ▼ to modify the blinking digit ENTER To recall a previously stored setup: SHIFT RECALL ▲ or ▼ to modify the blinking digit ENTER
Relative measurement	REL

Major Features Keystroke Summary (Cont.)

Feature	Press These Keys
Change display resolution.	SHIFT RESOLN ▲ or ▼ to modify the blinking digit ENTER
Selecting a sensor data table. Allows the user to select one of ten tables of sensor-specific calibration factors.	SHIFT SENSOR ▲ or ▼ to modify the blinking digit ENTER
Storing calibration factors for specific sensors. The user can store up to ten tables of calibration factors for later access using the SENSOR and FREQ keys.	SHIFT SPECIAL ▲ or ▼ to modify the blinking digit (Modify display to read "1 SENSR DATA") ENTER ▲ or ▼ to modify the blinking digit ▶ or ◀ to move to other digits ENTER EXIT (to leave SPECIAL mode)
Setting limits. The user can specify power limits and enable the Power Meter to indicate when the input power is outside the limits.	SHIFT SPECIAL ▲ or ▼ to modify the blinking digit (Modify the display to read "2 LIMITS") ENTER ▲ or ▼ to modify the blinking digit ◀ or ▶ to move to other digits ENTER EXIT (to leave SPECIAL mode)
Filter adjust. Reduces jitter in the display.	SHIFT SPECIAL ▲ or ▼ to modify the blinking digit (Modify the display to read "3 FILTER AVG") ENTER ▲ or ▼ to modify the blinking digit ENTER EXIT (to leave SPECIAL mode)

Major Features Keystroke Summary (Cont.)

Feature	Press These Keys
Setting the HP-IB Address.	SHIFT SPECIAL [▲] or [▼] to modify the blinking digit (Modify the display to read "4 HP-IB ADRS") ENTER [▲] or [▼] to modify the blinking digit [◀] or [▶] to move to other digits ENTER EXIT (to leave SPECIAL mode)
Performing a Self Test. The user can perform a variety of tests on the Power Meter.	SHIFT SPECIAL [▲] or [▼] to modify the blinking digit (Modify the display to read "5 SELF TEST") ENTER [▲] or [▼] to modify the blinking digit ENTER EXIT (to leave SPECIAL mode)

3-11. Basic Front Panel Checks

Description

The functions of the Power Meter are checked using power sensors and sensor cables. These checks provide reasonable assurance that most of the front panel controlled functions are being executed by the Power Meter.

Equipment

Power Sensor ..... HP 8481A
Sensor Cable .....HP 11730A Series

Procedure

1. The following procedure was developed using power sensor HP 8481A. Using other sensors such as the HP 8481B will result in different displays.

   Turn on the Power Meter and observe the power up routine with no power sensor connected to the input. During power up the diagnostics stored in ROM are executed under microprocessor control and turn on all the display segments and annunciators.

   When the self-test is finished, the Power Meter will display "SELF TEST OK". It will then display "NO SENSOR".

   If an error occurs during the power-up tests, the Power Meter will display an error code. For information about the specific error, refer to "Error Messages" in Appendix A.

2. Press the PRESET/LOCAL key, then the ENTER key. This sets the Power Meter parameters to:

   FREQ = 50 MHz
   OFFSET = 0.00 dB, Off
   REL = 0.00 dB, Off
   DUTY CYCLE = 1.000%, Off
   Low Limit = -90.00 dB, Off
   High Limit = +90.00 dB, Off
   PWR REF = Off
   Auto Filter
   Auto Range
   Measurement Units = dBm
   Group Execute Trigger Mode = Trigger with Delay (GT2)
   Trigger Mode = Free Run

3. Connect a power sensor with associated cable to the input. The error message "NO SENSOR" should disappear and the display will show either a power level or "PLEASE ZERO".

4. Connect the power sensor to the connector labeled POWER REF as shown in Figure 3-3.

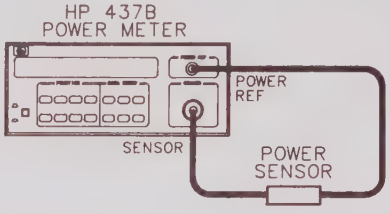


Figure 3-3. Front Panel Checks Setup

5. Press the ZERO key. Wait approximately 15 seconds for the zeroing routine to finish.

6. Press the CAL (SHIFTed ZERO) key. The Power Meter will display "REF CF 100.0%".

7. Using [▲], [▼], [◀], or [▶], modify the Power Meter's display until the power sensor's REF CAL FACTOR is displayed.

8. Press the ENTER key. The Power Meter will display "CAL *****". When the "CAL *****" display disappears, the calibration is finished.

9. Press the CAL FAC (SHIFTed FREQ) key. The Power Meter will display "CALFAC 100.0%".

10. Press the ENTER key.

11. Press the PWR REF (SHIFTed [▶]) key. The PWR REF annunciator will be enabled.

12. The Power Meter will display 0.00 dBm, ±0.02 dB.

13. Press the dBm/W key. The Power Meter will display 1.000 mW, ±.005 mW.

14. Press the dBm/W key to display dBm.

15. Press the OFFSET key. The display will read "OFS +00.00 dB".

16. Using [▲], [▼], [◀], or [▶], modify the display to read "OFS +03.00 dB".

17. Press the ENTER key.

18. The Power Meter will display 3.00 dBm ±0.02 dBm.

Note For information about other front panel keys and their functions, see the Detailed Operating Instructions.

3-12. HP-IB Checks

Description

These procedures check the Power Meter's ability to process or send the HP-IB messages described in Table 3-2. Only the Power Meter, a power sensor, a controller, and an HP-IB interface are needed to perform these checks.

These procedures do not check that all the Power Meter program codes are being properly interpreted and executed by the instrument. However, if the power-up sequence and front panel operation are good, the program codes, in all likelihood, will be correctly implemented.

The validity of these checks is based on the following assumptions:

1. The Power Meter performs properly when operated via the front panel keys (that is, in local mode). This can be verified by the Basic Functional Checks in this section.
2. The bus controller properly executes HP-IB operations.
3. The bus controller's interface properly executes the HP-IB operations.

If the Power Meter appears to fail any of these HP-IB checks, the validity of the above assumptions should be confirmed before attempting to service the instrument.

The select code of the controller's HP-IB interface is assumed to be 7. The address of the Power Meter is assumed to be 13 (its address set at the factory). This particular select code-address combination (that is, 713) is not necessary for these checks to be valid. However, the program lines presented here must be modified for any other combination.

These checks can be performed together or separately. Any special requirements for a check are described at the beginning of the check.

Initial Setup

The test setup is the same for all of the checks. Connect the equipment as shown in Figure 3-4.

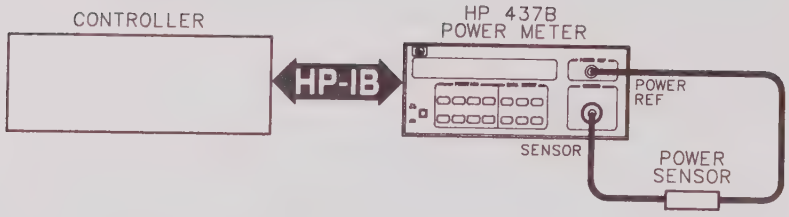


Figure 3-4. HP-IB Functional Checks Setup

Equipment

HP-IB Controller ..... HP 9000 Series 200/300 (BASIC 2.0)
Power Sensor ..... HP 848x series

Remote and Local Messages and PRESET/LOCAL Key

This check determines whether or not the Power Meter properly switches from local to remote control, from remote to local control, and whether or not the PRESET/LOCAL key returns the instrument to local control. Before beginning this check, set the LINE switch to OFF, then to ON.

Description	Series 200/300 (BASIC)
Send the Remote message (by setting the Remote Enable bus control line, REN, true and addressing the Power Meter to listen).	REMOTE 713

Check that the Power Meter's RMT and LSN annunciators are on.

Description	Series 200/300 (BASIC)
Send the Local message to the Power Meter	LOCAL 713

Check that the Power Meter's RMT annunciator is off but its LSN annunciator is on.

Description	Series 200/300 (BASIC)
Send the Remote message to the Power Meter.	REMOTE 713

Check that both the RMT and LSN annunciators are on. Press the PRESET/LOCAL key on the Power Meter. Check that the RMT annunciator is now off, but that the LSN annunciator remains on.

Sending the Data Message

This check determines whether or not the Power Meter properly issues Data messages when addressed to talk. Before beginning this check, set the Power Meter's LINE switch to OFF, then to ON. Press the PRESET/LOCAL key. (If an HP Series 200/300 controller is used, a short program is required to perform this check.)

Description	Series 200/300 (BASIC)
Address the Power Meter to talk and store its output in variable V.	10 V=0 20 ENTER 713;V
Display the value of V.	DISP V

Check that the Power Meter's TLK annunciator is on. The controller should display the same value as the one shown in the Power Meter's display. (Note that the Power Meter displays data using engineering notation. The controller may display the same value using a different format.)

Receiving the Data Message

This check determines whether or not the Power Meter properly receives Data messages.

Description	Series 200/300 (BASIC)
Send the first part of the Remote message (enabling the Power Meter to remote).	REMOTE 7
Address the Power Meter to listen (completing the Remote message), then send a Data message.	OUTPUT 713; "KB98.5EN"

Check that the Power Meter's RMT and LSN annunciators are on. Press the PRESET/LOCAL key. Press the CAL FAC key and ensure the CAL FAC is 98.5%.

Local Lockout and Clear Lockout/Set Local Messages

This check determines whether or not the Power Meter properly receives the Local Lockout message, disabling all front panel keys (including LOCAL). This check also determines whether or not the Clear Lockout/Set Local message is properly received and executed by the Power Meter. This check assumes the Power Meter is in remote mode.

Description	Series 200/300 (BASIC)
Send the Local Lockout message.	LOCAL LOCKOUT 713

Check that the RMT annunciator is on. Press the Power Meter's PRESET/LOCAL key. The RMT annunciator should remain on.

Description	Series 200/300 (BASIC)
Send the Clear Lockout/Set Local message.	LOCAL 7

Check that the Power Meter's RMT annunciator is off.

Description	Series 200/300 (BASIC)
Return the Power Meter to remote mode if the remaining checks in this section are to be performed.	REMOTE 713

Check that the Power Meter's RMT annunciator is on.

Clear Message

This check determines whether or not the Power Meter properly responds to the Clear message. This check assumes that the Power Meter is in remote mode.

Description	Series 200/300 (BASIC)
Send a Data message to enable the status message.	DIM A$[20] OUTPUT 713;"SM"
Send the Clear message.	CLEAR 713
Read the Data message.	Enter 713;A$
Print the message to the controller screen	Print A$

Verify that the data printed on the controller screen is a Data message and not a Status Message.

Abort Message

This check determines whether or not the Power Meter becomes unaddressed when it receives the Abort message. This check assumes the Power Meter is in remote mode the Power Meter is in remote mode.

Description	Series 200/300 (BASIC)
Address the Power Meter to listen.	OUTPUT 713

Check that the Power Meter's LSN annunciator is on.

Description	Series 200/300 (BASIC)
Send the Abort message, unaddressing the Power Meter from listening.	ABORTIO 713

Check that the Power Meter's LSN annunciator is off.

Status Byte Message

This check determines whether or not the Power Meter sends the Status Byte message. Before beginning this check, set the Power Meter's LINE switch to OFF then to ON and press the PRESET/LOCAL key.

Description	Series 200/300 (BASIC)
Place the Power Meter in serial-poll mode (causing it to send the Status Byte message).	SPOLL(713)

Check that the controller's display reads 0.

Require Service Message

This check determines whether or not the Power Meter can issue the Require Service message (set the SRQ bus control line true). This check can be performed in either local or remote mode.

Description	Series 200/300 (BASIC)
Send a Data message to set the Service Request Mask to 4.	OUTPUT 713 USING "2A,B"; "@1",4
Send a Data message containing an entry error. This causes the Require Service message to be sent.	OUTPUT 713; "RM 15 EN"

Check that the Power Meter's SRQ annunciator is on.

Description	Series 200/300 (BASIC)
Read the binary status of the controller's HP-IB interface and store the data in variable V (in this step, 7 is the interface's select code, and 2 is a status register for bus control lines).	10 V=0 20 STATUS 7,2;V
Display the value of the SRQ bit (in this step, 6 is the SRQ bit for the controller, numbered from 0).	30 DISP "SRQ="; BIT(V,6) 40 END

Check that the SRQ value is 1, indicating that the Power Meter issued the Require Service Message.

Status Bit Message

This check determines whether or not the Power Meter sends the Status Bit message. This check can be performed in either local or remote mode. If the Power Meter's SRQ annunciator is off, perform the first part of the Require Service message check before beginning this check.

Description	Series 200/300 (BASIC)
Configure the Power Meter to respond to a parallel poll with positive-true logic on HP-IB data line DIO3.	SEND 7;LISTEN 13 CMD 5 SCG 10
Place the Power Meter in parallel poll mode (causing it to send the Status Bit message).	PPOLL(7)

Check that the SRQ annunciator is on and that the response to the parallel poll is 4, indicating that the Power Meter issued the Status Bit message.

Description	Series 200/300 (BASIC)
Unconfigure the Power Meter from responding to a parallel poll.	SEND 7; LISTEN 13 CMD 5 SCG 18
Place the Power Meter in parallel poll mode.	PPOLL(7)

Check that the SRQ annunciator is on and that the response to the parallel poll is 0, indicating that the Power Meter is no longer configured to respond to a parallel poll. Set the LINE switch to OFF, then to ON, to turn off the SRQ annunciator.

Trigger Message

This check determines whether or not the Power Meter responds to a Trigger message. This check assumes that the Power Meter is in remote mode.

Description	Series 200/300 (BASIC)
Send a Data message to place the Power Meter in the Trigger Hold mode.	OUTPUT 713;"TRO"
Send the Trigger message.	TRIGGER 713
Address the Power Meter to talk and store the data in variable V.	10 V=10 20 ENTER 713;V
Display the value of V.	30 DISP V 40 END

Check that the Power Meter's RMT and TLK annunciators are on and that the controller displays the same value as the one shown in the Power Meter's display. (Note that the Power Meter displays data using engineering notation. The controller may display the same value using a different format.)

3-13. Remote Operation, Hewlett-Packard Interface Bus

The Power Meter can be operated through the Hewlett-Packard Interface Bus (HP-IB). HP-IB is Hewlett-Packard's implementation of ANSI/IEEE Standard 488.1. Bus compatibility, programming, and data formats are described in the following paragraphs.

All front panel functions are programmable via HP-IB except setting the LINE switch and activating the SHIFT key. The SHIFT key is not programmable because the shifted functions have their own program codes.

A quick test of the Power Meter's HP-IB interface is described in this section under HP-IB Functional Checks. These checks verify that the Power Meter can respond to or send each of the applicable bus messages described in Table 3-2. For more information about HP-IB, refer to ANSI/IEEE Standard 488.1, the Hewlett-Packard Electronic Systems and Instruments catalog, and the booklet "Improving Measurements in Engineering and Manufacturing" (HP part number 5952-0058).

3-14. HP-IB Compatibility

The Power Meter's complete bus compatibility as defined by ANSI/IEEE Standard 488.1 is described at the end of Table 3-2. Table 3-2 also summarizes the Power Meter's twelve messages in the "HP-IB Message" column.

Table 3-2. Message Reference Table

HP-IB Message	Applicable	Response	Related Command	Interface Functions
Data	Yes	All Power Meter operations, (except setting the LINE switch and setting the HP-IB address) and remote-only functions are bus programmable. All measurement results are available to the bus.		AH1, SH1 T5, TE0 L3, LE0
Trigger	Yes	The Power Meter's response to bus command GET (Group Execute Trigger) can be programmed. The default condition is Trigger With Delay (GT2). If in remote and addressed to listen, the Power Meter makes a measurement according to the previously programmed setup.	GET	DT1
Clear	Yes	All HP-IB inputs and outputs are cancelled	DCL, SDC	DC1
Remote	Yes	Remote mode is enabled when the REN bus control line is true. Remote mode is not entered, however, until the first time the Power Meter is addressed to listen. The front panel RMT annunciator lights when the instrument is actually in remote mode. When entering remote mode, no instrument settings or functions are changed but all front panel keys, except PRESET/LOCAL, are disabled.	REN	RL1

Table 3-2. Message Reference Table (Cont.)

HP-IB Message	Applicable	Response	Related Command	Interface Functions
Local	Yes	The Power Meter returns to local mode (front panel control). It responds equally to the Go To Local (GTL) bus command and the front panel PRESET/LOCAL key.	GTL	RL1
Local Lockout	Yes	Disables all front panel keys, including PRESET/LOCAL. Only the controller can return the Power Meter to local (front panel) control.	LLO	RL1
Clear Lockout/ Set Local	Yes	The Power Meter returns to local mode (front panel control). Local Lockout is cleared when the bus control line goes false.	REN	RL1
Pass Control/ Take Control	No	The Power Meter has no controller capability.		C0
Require Service	Yes	The Power Meter sets the SRQ bus control line true if one of the following conditions exists and has been enabled (via the Service Request Mask) to send the message for that condition: data ready, cal/zero completed, entry error, measurement error, or over/under limits.	SRQ	SR1

Table 3-2. Message Reference Table (Cont.)

HP-IB Message	Applicable	Response	Related Command	Interface Functions
Status Byte	Yes	The Power Meter responds to a Serial Poll Enable (SPE) bus command by sending an 8-bit byte when addressed to talk. If the instrument is holding the SRQ bus control line true (issuing the Require Service message), bit position 6 in the Status Byte and the bit representing the condition causing the Require Service message to be issued will both be true. The bits in the Status Byte are latched but can be cleared by removing the causing condition and then reading the Status Byte or by receiving the Clear Status (CS) program code.	SPE, SPD	T5
Status Bit	Yes	The Power Meter responds to a Parallel Poll Enable (PPE) bus command by sending a bit on a controller selected HP-IB data line.	PPE, PPD, PPC, PPU	PP1
Abort	Yes	The Power Meter stops talking and listening.	IFC	T5, TE0, L3, LE0

Complete HP-IB capability as defined in ANSI/IEEE Standard 488.1 is:
SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT1, C0

3-15. Remote Mode

Remote Capability. The Power Meter communicates on the bus in both remote and local modes. In remote, most of the Power Meter's front panel keys are disabled. Front panel displays, however, remain active and valid.

In remote, the Power Meter can be addressed to talk or listen. When addressed to listen, the Power Meter responds to the Data, Trigger, Clear, Remote, and Local messages. When addressed to talk, the Power Meter can issue the Data and Status Byte messages. Whether addressed or not, the Power Meter responds to the Clear, Local Lockout, Clear Lockout/ Set Local, and Abort messages. In addition, the Power Meter may issue the Require Service and Status Bit messages.

Local-to-Remote Changes. The Power Meter switches to remote operation upon receipt of the Remote message. The Remote message has two parts:

a. The remote enable bus control line (REN) is set true, and,

b. the device listen address is received once (while REN is true).

When the Power Meter switches to remote, the front panel RMT annunciator turns on. The Power Meter's control settings remain unchanged with the local-to-remote transition.

3-16. Local Mode

Local Capability. In local, the Power Meter's front panel controls are fully operational. The instrument will respond to the Remote message. The Power Meter can also send a Require Service message, a Status Byte message, and a Status Bit message.

Remote-to-Local Changes. The Power Meter always switches from remote to local whenever it receives the Local message (GTL) or the Clear Lockout/Set Local message. (The Clear Lockout/Set Local message sets the remote enable bus control line [REN] false.) If not in Local Lockout mode, the Power Meter switches to local from remote whenever the front panel PRESET/LOCAL key is pressed.

Local Lockout. A local lockout is recommended for purely automatic applications. Local lockout disables the PRESET/LOCAL key and allows return-to-local only under program control.

Note

Return-to-local can also be accomplished by setting the Power Meter's LINE switch to STBY, then to ON. However, this technique has some disadvantages:

a. Many of the Power Meter's parameters are set to default states. This may cause the measured power reading to change.

b. There are several HP-IB conditions that reset to default states at turn-on.

3-17. Addressing

The Power Meter interprets the byte on the eight HP-IB data lines as an address or a bus command if the bus is in the command mode. The command mode is defined as the attention control line (ATN) being set true and the interface clear control line (IFC) set false. Whenever the Power Meter is addressed (whether in local or remote), either the talk (TLK) or listen (LSN) annunciator on the front panel turns on.

The Power Meter's HP-IB address is set from the front panel as follows:

1. Press the PRESET/LOCAL key.
2. Press the SHIFT key.
3. Press the SPECIAL key (SHIFTed PRESET/LOCAL). The display will read "0 SPL STATUS".
4. Press [▲] or [▼] until the display reads "4 HP-IB ADRS".
5. Press the ENTER key. The display will read "ADDRESS 13" with one blinking digit.
6. Modify the blinking digit using [▲], [▼], [▶], or [◀] until the desired HP-IB address is displayed.
7. Press the ENTER key.

Listen Only Mode. The Power Meter is placed in Listen Only mode when its HP-IB address is set to 40. The Listen Only mode is provided to allow Power Meter to accept programming from devices other than controllers.

Talk Only Mode. The Power Meter is placed in Talk Only mode when its HP-IB address is set to 50. In this mode, the instrument is configured to send data messages whenever the bus is in the data mode (attention control line [ATN] false).

3-18. Turn-on Default Conditions

Several HP-IB parameters are reset at turn-on. The parameters and their default conditions are listed below.

- HP-IB Local Mode
- Unaddressed
- Service Request Mask cleared
- Status Byte cleared
- Free Run Trigger Mode
- GT2 (Trigger with Delay) response to Trigger message
- Parallel Poll data line unassigned
- Event Status Register = 128
- Event Status Enable Mask = 0

3-19. Data Messages

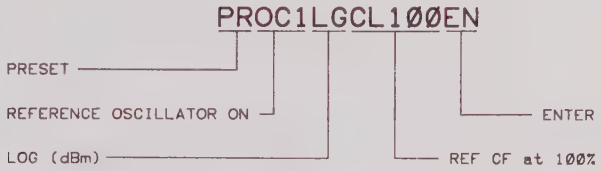
The Power Meter communicates on the interface bus primarily with Data messages. Data messages consist of one or more bytes sent over the bus' data lines when the bus is in the data mode (ATN bus control line false). Unless it is set to Talk Only, the Power Meter receives Data messages when addressed to listen. Unless it is set to Listen Only, the Power Meter sends Data messages or the Status Byte message when addressed to talk.

Virtually all instrument operations available in local mode can be performed in remote mode via Data messages. The only exceptions are: changing the LINE switch, activating the SHIFT key, or changing the HP-IB address. The Power Meter may also be triggered via Data messages to make measurements at a particular time.

3-20. Receiving the Data Message

The Power Meter responds to Data messages when it is enabled to remote (REN bus control line true) and it is addressed to listen. The instrument remains addressed to listen until it receives its talk address, an Abort message, or a universal unlisten command.

Data Input Format. The Data message string, or program string, consists of a series of ASCII codes. Each instrument command code is typically equivalent to a front panel keystroke in local mode. Numbers entered via HP-IB, however, are entered using ASCII strings. (Numbers entered from the keyboard are entered using [▲], [▼], [◀], and [▶].) Example 1 shows a typical program string.



EXAMPLE 1: Typical Program String

Program Codes. All of the HP-IB codes normally used by the operator to control the Power Meter are given in Table 3-5, HP-IB Code to Parameter Summary. All front panel keys except LOCAL and SHIFT have corresponding program codes. Lower case alpha characters are interchangeable with upper case characters. The number 0 and the letter O are not interchangeable.

Numeric data can be entered in fixed, floating point, or exponential format.

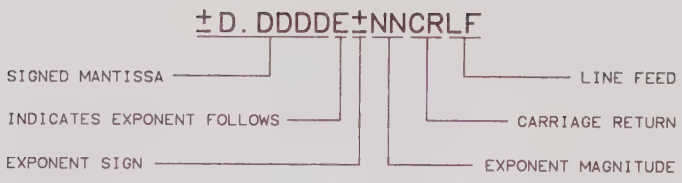
Note

All measurement parameter entries must be terminated with the program code "EN". (This is equivalent to pressing the ENTER key in local mode.) All frequency entries must be terminated with HZ, KZ, MZ, or GZ. For DUTY CYCLE (DY), CAL FAC (KB), and CAL (CL), the percent sign (%) can be used in place of EN.

3-21. Sending the Data Message

The Power Meter sends Data messages when addressed to talk. The instrument remains configured to talk until it is unaddressed to talk by the controller. To unaddress the Power Meter, the controller must send the Power Meter's listen address, a new talk address, an Abort message, or a universal untalk command.

Data Output Format. The output data is usually formatted as a real constant in exponential form. That is; first the sign, then a digit, a decimal point, and four digits followed by the letter E (which indicates that an exponent follows). The letter E is followed by a signed power-of-ten multiplier. The string is terminated by a carriage return (CR) and a line feed (LF). With the last byte of each output string, the Power Meter sets the EOI (End of Information) control line true.



EXAMPLE 2: Typical Data Output String

When an error is output to the bus, it follows the format described above.

Note

As long as the front panel display indicates a measurement error condition (E1-39), the Power Meter sends 9.00XXE+40 as the measured data when addressed to talk. XX in the Data message is the error code for that particular error. Refer to the Error Messages section of the Detailed Operating Instructions for interpretation of the code.

Exceptions to this format are the data output for the following functions:

Learn Mode
Status Message
Identification
Read Service Request Mask Value
Output Display
Read Event Status Register Mask Value
Read Event Status Register Value
Read Service Request Mask Value

Each of these functions is enabled by first addressing the Power Meter to listen. Then the Power Meter must receive a Data message with the appropriate program code. When the Power Meter is adressed to talk, it will output data for the selected function.

The output format for these functions is described in the following paragraphs. Service Request Mask Value is explained later under Sending the Service Request Mask Value.

Learn Mode. Learn Mode is a function that allows the Power Meter to send instrument configurations to the controller's memory.

Whenever data is being transferred between controller and Power Meter, it must do so in uninterrupted strings. If a data string is broken or interrupted, the data could be lost or offset, and misinterpreted by the Power Meter. An offset of data bytes can persist until EOI is read.

After receiving the program code LP2, and when addressed to talk, the Power Meter sends 2 ASCII characters, @ and 2, followed by a string of 58 8-bit binary bytes. The last byte is sent with the EOI bus line true, thus terminating the message. This binary data can then be stored in the controller's memory.

The binary string that is sent by the Power Meter contains the following information:

REL mode status (on or off)
Reference oscillator status (on or off)
Current reference value if in REL mode
Measurement units (dBm or watts)
CAL FAC value
REF CF value
Offset value and status (on or off)
Selected Range
Selected Filter
Sensor ID number
DUTY CYCLE value and status (on or off)
Resolution
FREQ value
Limits

When the Power Meter is addressed to listen, the binary data can be returned to the Power Meter. The Power Meter will then change accordingly.

Status Message. This function enables the Power Meter's current state to be read under program control. After receiving an SM program code (Status Message) and when addressed to talk, the Power Meter sends a string of 26 ASCII characters followed by a carriage return (CR) and a line feed (LF). With the last byte of the string, the Power Meter sets the EOI line true. The Status Message is updated only after a measurement. The Status Message can be interpreted with the information shown in Figure 3-5 and Table 3-3.

Identification. This function is used to identify the Power Meter's model number and the firmware version. After receiving program code *IDN? and when addressed to talk, the Power Meter sends the following string: HEWLETT-PACKARD, 437B,, X.X. 437B is the instrument model number and X.X is the firmware version number.

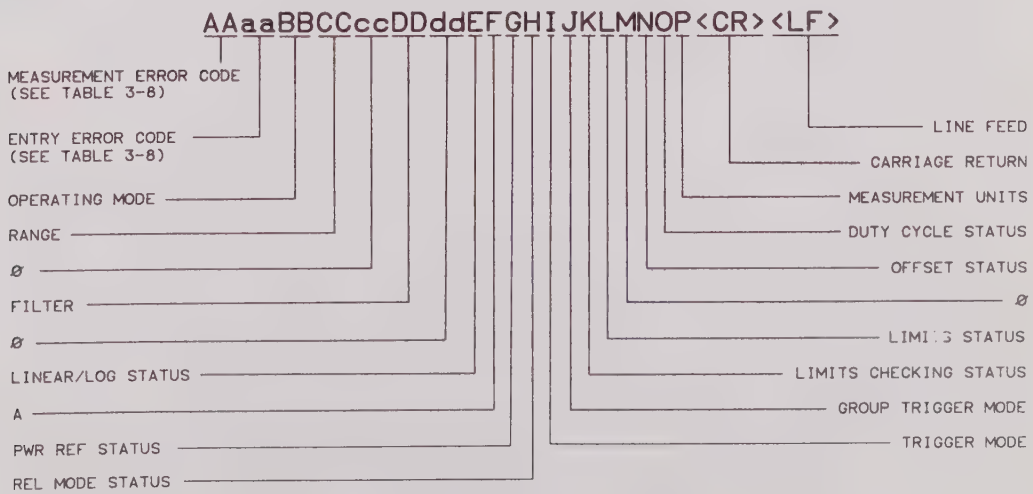


Figure 3-5. Status Message Format

Table 3-3. Status Message Information

Code	Mode	Description
AA	Measurement Error	See Table 3-8
aa	Entry Error	See Table 3-8
BB	Operating Mode	06=Zeroing 08=Calibration
CC	Range	Manual Range: 01=1 02=2 03=3 04=4 05=5 Auto Range: 11=1 12=2 13=3 14=4 15=5
cc		0
DD	Filter	Manual Filter: 00=1 01=2 02=4 03=8 04=16 05=32 06=64 07=128 08=256 09=512 Auto Filter:10=1 11=2 12=4 13=8 14=16 15=32 16=64 17=128 18=256 19=512
dd		0
E	Linear/Log Status	0=Linear 1=Log
F		A
G	PWR REF Status	0=Off 1=On
H	REL Mode Status	0=Off 1=On
I	Trigger Mode	0=Free Run 1=Standby
J	Group Trigger Mode	0=GT0 1=GT1 2=GT2
K	Limits Checking Status	0=Disabled 1=Enabled
L	Limits Status	0=In limits 1=Over limit 2=Under low limit
M		0
N	Offset Status	0=Off 1=On
O	Duty Cycle Status	0=Off 1=On
P	Measurement Units	0=Watts 1=dBm 2=% 3=dB

3-22. Receiving the Clear Message

The Power Meter responds to the Clear message by aborting any pending HP-IB input or output. The Power Meter responds equally to the Selected Device Clear (SDC) bus command when addressed to listen, and the Device Clear (DCL) bus command whether addressed or not.

3-23. Receiving the Trigger Message

When in remote and addressed to listen, the Power Meter responds to a Trigger message (the Group Execute Trigger bus command [GET]) by executing one of the pre-programmed codes shown in Table 3-4. If none of the codes has been pre-programmed (via a Data message), the Power Meter responds to the Trigger message by executing one settled-measurement cycle (GT2), which is the default condition at turn-on. Refer to the Detailed Operating Instructions for more information.

Table 3-4. Response to a Trigger Message

Program Code	Power Meter Response
GT0	Ignore Group Execute Trigger
GT1	Trigger Immediate (TR1)
GT2	Trigger with Delay (TR2)

3-24. Receiving the Remote Message

The Remote message has two parts. First, the remote enable control line (REN) is held true, then the device listen address is sent by the controller. These two actions combine to place the Power Meter in remote mode. Thus, the Power Meter is enabled to go into remote when controller begins the Remote message, but it does not actually switch to remote until addressed to listen the first time. No instrument settings are changed by the transition from local to remote. When actually in remote, the Power Meter lights the front panel RMT annunciator.

3-25. Receiving the Local Message

The Local message is the means by which the controller sends the Go To Local (GTL) bus command. If addressed to listen, the Power Meter returns to front panel control when it receives the Local message. If the instrument was in local lockout when the Local message was received, front panel control is returned, but lockout is not cleared. Unless it receives the Clear Lockout/ Set Local message, the Power Meter will return to local lockout the next time it goes to remote. No instrument settings are changed by the transition from remote to local.

When the Power Meter goes to local mode, the front panel RMT annunciator turns off. However, when the Power Meter is being addressed (whether in local or remote), its front panel LSN or TLK annunciator lights.

3-26. Receiving the Local Lockout Message

The Local Lockout message is the means by which the controller sends the Local Lockout (LLO) bus command. If in remote, the Power Meter responds to the Local Lockout message by disabling the front panel PRESET/LOCAL key. The local lockout mode prevents loss of system control due to someone accidentally pressing front panel keys.

If, while in local, the Power Meter is enabled to remote (that is, REN is set true) and it receives the Local Lockout message, it will switch to remote mode with local lockout the first time it is addressed to listen. When in local lockout, the Power Meter can be returned to local only by the controller (using Local or Clear Lockout/Set Local messages), by setting the LINE switch to OFF and back to ON, or by removing the bus cable.

3-27. Receiving the Clear Lockout/Set Local Message

The Clear Lockout/Set Local message is the means by which the controller sets the Remote Enable (REN) bus control line false. The Power Meter returns to local mode (full front panel control) when it receives the Clear Lockout/Set Local message. When the Power Meter goes to local mode, the front panel RMT annunciator turns off.

3-28. Receiving the Pass Control Message

The Power Meter does not respond to the Pass Control message because it cannot act as a controller.

3-29. Sending the Require Service Message

The Power Meter sends the Require Service message by setting the Service Request (SRQ) bus control line true. The instrument can send the Require Service message in either local or remote mode. When the Power Meter is sending the Require Service message, the front panel SRQ annunciator is enabled. The Require Service message is cleared when a serial poll is executed by the controller or when a "CS" (clear status byte) or "*CLS" (clear all status bytes) program code is received via a Data message.

There are six conditions that can be enabled to cause the Require Service message to be sent. These conditions, which are enabled by the Service Request Mask, are described below.

Data Ready: When the Power Meter has a data point requested by a trigger command.

Cal/Zero Completed: When the Power Meter has completed a calibration or zeroing cycle.

Entry Error: When a number is entered via HP-IB that is out of the allowable range for the selected parameter.

Measurement Error: When the power applied to the sensors is incorrect for the current instrument configuration.

Over/Under Limits: When the limits checking function is enabled and the measured power is greater than the high limit or lower than the low limit.

Event Status Register: When a specified condition in the Event Status Register occurs and the corresponding bit in the Event Status Enable Register is enabled (via *ESE), this bit will be set true.

Service Request Mask. The Service Request Mask determines which bits can set the Status Byte's RQS bit true (see Figure 3-6). When the RQS bit is true, the SRQ line is also true.

The Service Request Mask is set by the program code "*SRE" followed by an ASCII value between 0 and 255. Additionally, the Service Request Mask can be set by sending the program code "@1" followed by an ASCII value. The ASCII value is determined by summing the weights of each bit to be checked. Each bit, if true, enables the corresponding condition to set the RQS bit true. At turn-on, the Service Request Mask is cleared (set to 0).

Sending the Service Request Mask Value. After receiving an "*SRE?" program code (Read Service Request Mask Value) and when addressed to talk, the Power Meter will send an ASCII value between 0 and 255 that describes the present state of the mask. The Service Request Mask value can also be read by sending the program code "RV". The ASCII value is determined by summing the weights of the bits that are set true. The bit pattern can be interpreted with the information in Figure 3-6.

Note

This byte is sent with the EOI line true, thus terminating the message.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Require Service (RQS)	Event Status Register	Over/ Under Limit	Measure-ment Error	Entry Error	Cal/ Zero Complete	Data Ready
Value =128	Value =64	Value =32	Value =16	Value =8	Value =4	Value =2	Value =1

Figure 3-6. The Status Byte and Service Request Mask

3-30. Sending the Status Byte Message

After receiving a Serial Poll Enable (SPE) bus command and when addressed to talk, the Power Meter sends the Status Byte message. The Status Byte message consists of one 8-bit byte in which seven of the bits are set according to the conditions described under Sending the Require Service Message. The bit pattern of the Status Byte is shown in Figure 3-6. Note that bit 7 is always set to 0. The remaining bit is the RQS bit.

If one or more of the six conditions described above is both present and enabled by the Service Request Mask, the bits corresponding to those conditions (and also bit 6, the RQS bit), are set true and the Require Service message is sent. If one or more of the six conditions occurs but has not been enabled by the Service Request Mask, the corresponding bits are still set true. However, if a condition has not been enabled by the Mask, it cannot cause the RQS bit to be set true.

Once the Power Meter receives the serial poll enable (SPE) bus command, it is no longer able to alter the Status Byte. If a bit has been enabled and that condition occurs after the RQS bit has been set true, the bit is stored in a buffer and is read the next time the Power Meter receives the SPE bus command.

After the Status Byte message has been sent, it will be cleared if the Serial Poll Disable (SPD) bus command is received, if the Abort message is received, or if the Power Meter is unaddressed to talk. Bits stored in the buffer waiting to be read, however, are not cleared. Regardless of whether or not the Status Byte message has been sent, the Status Byte and any Require Service message pending will be cleared if a Clear Status (CS) or Clear Status Bytes (*CLS) program code is received by the Power Meter.

The value of the Status Byte can be read using the "*STB?" (Status Byte Query) command. When the Power Meter receives the "*STB?" command, it returns an ASCII value between 0 and 127. This value is the sum of the weighted values of the bits that are set. For example, if the Power Meter returns "012", bits 2 (value=4) and 3 (value=8) are set true. The "*STB?" command does not clear the Status Byte.

3-31. Event Status Register

The Event Status Register is a second status byte that is available to the user. It consists of an 8-bit byte similar to the Status Byte and is diagrammed in Figure 3-7. The bits in the Event Status Register are set true when the specified event occurs. The setting of the Event Status Register can be read by sending the command "*ESR?". Upon receiving this command, the Power Meter will send an ASCII value between 0 and 255 that describes the present state of the register. The ASCII value is determined by summing the weighted values of the bits that are set.

The bits in the Event Status Register are defined below:

Power On: This bit is set when the Power Meter's LINE switch is set from STDBY to ON.

Command Error: This bit is set when an incorrect HP-IB code is sent to the Power Meter. For example, the command "QX" is a command error.

Execution Error: This bit is set when incorrect data is sent to the Power Meter. For example, the command "FR-3GZ" is an execution error.

Device Dependent Error: This bit is set true whenever a measurement error (error 1-49) occurs.

A bit being set true in the Event Status Register will cause bit 5 of the Status Byte to be set only if the corresponding bit in the Event Status Enable Register is enabled. The Event Status Enable Register is similar to the Service Request Mask in that it allows the user to select which bit(s) in the Event Status Register will set bit five in the Status Byte.

The Event Status Enable Register is set by sending the program code "*ESE" followed by an ASCII value. The ASCII value is determined by summing the weights of each bit to be checked. The setting of the Event Status Enable Register can be read by sending the command "*ESE?". Upon receiving this command, the Power Meter will send an ASCII value that describes the present state of the register. The ASCII value is determined by summing the weighted values of the bits that are set.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Power On	0	Command Error	Execution Error	Device Dependent Error	0	0	
Value =128	Value =64	Value =32	Value =16	Value =8	Value =4	Value =2	Value =1

Figure 3-7. Event Status Register and Event Status Enable Register

3-32. Sending the Status Bit Message

The Power Meter sends the Status Bit message (if configured to do so) as part of the interface's response to the Parallel Poll Enable (PPE) bus command. In order for the Power Meter to respond to a PPE bus command, the instrument must be assigned (by the controller) a single HP-IB data line on which to respond. The controller also assigns the logic sense of the bit. Both tasks are accomplished by the Parallel Poll Configure (PPC) bus command. If the Power Meter is sending the Require Service message, it will set its assigned status bit true. The Power Meter can send the Status Bit message without being addressed to talk.

The data line on which the Power Meter is assigned to respond is cleared by sending the Parallel Poll Unconfigure (PPU) bus command. At turn-on, the data line is unassigned.

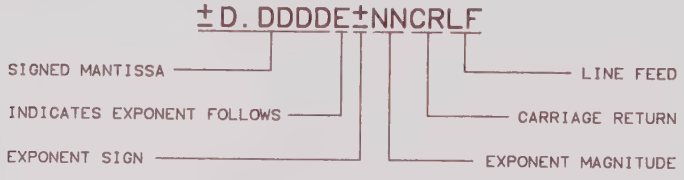
3-33. Receiving the Abort Message

The Abort message is the means by which the controller sets the Interface Clear (IFC) bus control line true. When the Abort message is received, the Power Meter becomes unaddressed and stops talking and listening.

3-34. HP-IB Syntax and Characteristics Summary

Data Input Format: Typically the same as front panel keystrokes in local mode. Most numeric entries sent over the HP-IB must be terminated with the program code "EN" (for ENTER).

Data Output Format: Output format when no other talk mode has been defined:



Output format for Learn Mode: 60 bytes [EOI].

Output format for Identification: HEWLETT-PACKARD, 437B,, X.X.

Output format for Status Message: 26 ASCII characters [CR] [LF] [EOI].

Output format for Service Request Mask Value: 1 byte [EOI].

Output format for *SRE?, *STB?, *ESR?, *ESE?, ERR?
XXX [CR] [LF] [EOI] where XXX=000 to 255 in ASCII characters.

Return to Local: Front panel PRESET/LOCAL key if not locked out.

Table 3-5. HP-IB Codes to Parameter Summary

HP-IB Code	Parameter
CL	CAL[1]
*CLS	Clear all Status Registers
CS	Clear the Status Byte
CT0 - CT9	Clear sensor data tables 0-9[1]
DA	All display segments on
DC0	Duty Cycle on
DC1	Duty Cycle off
DD	Display Disable
DE	Display enable
DN	▼
DU	Display user message
DY	Duty Cycle (Enter duty cycle value)[1]
EN	ENTER
ERR?	Device error query
*ESR?	Event Status Register query
*ESE	Set the Event Status Register Enable Mask
*ESE?	Event Status Register Enable Mask query
ET0 - ET9	Edit sensor cal factor table 0-9[1]
EX	EXIT
FA	Automatic filter selection
FH	Filter hold
FM	Manual filter selection[1]
FR	FREQ[1]
GT0	Ignore Group Execute Trigger (GET) bus command
GT1	Trigger Immediate response to GET command
GT2	Trigger with Delay response to GET command
GZ	Gigahertz
HZ	Hertz
ID	HP-IB Identification query
*IDN?	HP-IB Identification query
KB	CAL FAC[1]
KZ	Kilohertz
LG	Log display
LH	High limit[1]
LL	Low limit[1]
LM0	Disable limits checking function
LM1	Enable limits checking function
LN	Linear display
LP	Learn Mode
LT	◄
MZ	Megahertz
OC0	Reference oscillator off
OC1	Reference oscillator on
OD	Output display text
OF0	Offset off
OF1	Offset on
OS	OFFSET (enter offset value)[1]

Table 3-5. HP-IB Codes to Parameter Summary (Cont.)

HP-IB Code	Parameter
PCT	Percent (can terminate DUTY CYCLE, CAL FAC, and REF CF)
PR	PRESET
RA	AUTO RNG
RC	RECALL[1]
RE	RESOLN[1]
RF0 - RF9	Enter sensor REF CAL FACTOR[1]
RH	Range hold
RL0	Exit REL mode
RL1	Enter REL mode using new REL value
RL2	Enter REL mode using old REL value
RM	SET RANGE[1]
*RST	Soft reset
RT	▷
RV	Read Service Request Mask Value
SE	SENSOR[1]
SM	Status Message
SN0 - SN9	Enter sensor serial number[2]
SP	SPECIAL
*SRE	Set the Service Request Mask Value
*SRE?	Service Request Mask query
ST	STORE[1]
*STB?	Read the Status Byte
TR0	Trigger Hold
TR1	Trigger Immediate
TR2	Trigger with Delay
TR3	Trigger-Free Run
*TST?	Self test query
UP	△
ZE	ZERO
@1	Prefix for Status Mask
@2	Learn Mode prefix
%	Terminates Sensor Data table calibration factor entry (Can be used for DUTY CYCLE, CAL FAC, and REF CF)

[1] These HP-IB codes require a numeric entry followed by the program code EN (ENTER).

[2] This HP-IB code will use the next 6 characters (0-9, A-Z, or an underscore) as input data.

Note

This table lists the titles of the Detailed Operating Instructions according to their function. The Detailed Operating Instructions are arranged in alphabetical order according to the titles shown below. Titles in ALL CAPITAL LETTERS indicate front panel keys.

Table 3-6. Listing of Detailed Operating Instructions

Calibration	**Miscellaneous**
CAL	Arrows
CAL FAC	Display
ZERO	ENTER
	Error Messages
Measurement	EXIT
FREQ	PRESET
REL	RECALL
SENSOR	SPECIAL
Sensor Data	STORE
	Trigger
	Parameters
	AUTO RNG
	DUTY CYCLE
	Filters
	Limits
	OFFSET
	RESOLN
	SET RANGE

Arrows

Description

The arrow keys ([▲], [▼], [◀], [▶]) are used to modify numeric data that is to be entered into the Power Meter. When one of the function keys is pressed, a numeric string is displayed with one blinking digit. The [▲] and [▼] keys are used to modify the blinking digit. The [◀] and [▶] keys are used to move to other digits.

The arrow keys have two functions when the Power Meter is in SPECIAL mode: the regular function and the SHIFTed function.

Regular Function. The regular function of the arrow keys (when in SPECIAL mode) is the same as when the Power Meter is not in SPECIAL mode: they modify numeric data input.

Shifted Function. There are two SHIFTed functions:

1. SHIFTed [▲] and [▼] will "scroll" the data in the display. SHIFTed [▲] allows the user to return to the previous display, SHIFTed [▼] allows the user to advance to the next display. This function is advantageous when data is being entered into the Sensor Data tables.

2. SHIFTed [◀] and [▶] will move the decimal point of displayed numeric data left or right. This function can be used only when frequency data is being entered into the Sensor Data tables.

When in SPECIAL mode, the usual SHIFTed functions of the arrow keys (STORE, RECALL, SENSOR, and PWR REF) are disabled.

Local Procedure

When entering numeric data into the Power Meter, use [▲] and [▼] to modify the display's blinking digit. Use [◀] and [▶] to move to other digits or the sign (+ or -) of the parameter.

HP-IB Program Codes

Parameter	Program Codes
▲	UP
▼	DN
◀	LT
▶	RT

Comments

The RESOLN, SET RANGE, and SENSOR keys use the ▲ and ▼ keys only. The ◀ and ▶ keys are ignored.

Auto Range

Description

The Power Meter divides each sensor's power range into 5 ranges of 10 dB each. Range 1 is the most sensitive (lowest power levels), and Range 5 is the least sensitive (highest power levels). Range 5 can be less than 10 dB if the sensor's power range is less than 50 dB. The range can be set either automatically or manually.

AUTO RNG automatically selects the correct range for the current measurement.

Local Procedure

To select the automatic ranging function, press AUTO RNG (SHIFTed SET RANGE).

Remote Procedure

The program code to enable the automatic range function is RA. to enable the auto range function, send the command RA.

HP-IB Program Codes

Parameter	Program Codes
AUTO RNG	RA

Comments

PRESET sets the Power Meter to AUTO RNG.

There is no front panel indication when the Power Meter is in AUTO RNG mode.

If you are only interested in power readings in one range, SET RANGE can be used for faster readings.

Use manual range when using the rear panel RCDR (recorder) output so that the Power Meter does not change ranges while outputting data. The recorder output provides a 0 to 1 V dc output for each range.

Pressing the AUTO RNG key when the Power Meter is already in auto range mode causes the instrument to step down one range if the measurement is in the bottom 20% of the current range (there is a 20% overlap on ranges). If the power reading can be displayed on either range, the Power Meter stays on the lower range. In linear mode, this provides a means for down ranging to obtain greater resolution in borderline situations. For example, with an HP 8481A power sensor measuring a power level of 1.153 mW, the range could be either range 4 (1 to 10 mW) or range 3 (0.1 to 1.2 mW with 20% overlap). The display in range 4 would show 1.15 mW, but in range 3 would show 1.153 mW.

CAL

Description

CAL is used to calibrate the Power Meter and any compatible power sensor to a known reference. During the calibration cycle, the gain of the Power Meter is adjusted so that the front panel display reads 1.000 mW when the sensor is connected to a 1.00 mW reference oscillator.

Pressing the CAL key enables entry of the power sensor's reference calibration factor. The allowable range of values for CAL is 50.0 to 120.0%.

Local Procedure

1. Connect a power sensor to the Power Meter with a power sensor cable.
2. Connect the sensor to the reference oscillator on the Power Meter's front panel.
3. Press CAL (SHIFTed ZERO). The Power Meter will display the reference calibration factor of the selected sensor with one digit blinking. (The Power Meter will display "REF CF DDD.D%").
4. Examine the power sensor to determine the REF CAL FACTOR.
5. Modify the digits in the Power Meter's display (see below) until the power sensor's REF CAL FACTOR is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
6. Press ENTER.

When the REF CAL FACTOR has been ENTERed, the Power Meter will display "CAL *****".

Remote Procedure

The Program code for CAL is CL. The Power Meter is programmed to perform the calibration routine by sending the CL command, followed by the REF CAL FACTOR, and terminated by the EN (ENTER) command, the percent (%) sign, or the PCT (percent) command.

Example:

To calibrate a sensor to the Power Meter with a REF CAL FACTOR of 98.5%:

CL98.5EN or CL98.5% or CL98.5PCT

HP-IB Program Codes

Parameter	Program Code
CAL Percent ENTER	CL %,PCT EN

Programming Example

The following program is written in BASIC 5.0 for the HP 9000 series 200 or 300 controllers. This program calibrates the Power Meter with a REF CF of 100% and displays whether the calibration was successful or unsuccessful. Lines 3000 through 3260 comprise a subroutine that contains the calibration routine. Lines 10 through 90 run the subroutine and print the result.

```
10    ! Program 'CAL_437B'
20    !
30    CALL Cal_437b(713,100,Err)
40    IF Err=0 THEN
50    PRINT "CAL SUCCESSFUL"
60    ELSE
70    PRINT "CAL UNSUCCESSFUL"
80    END IF
90    END
3000  SUB Cal_437b(Hpib_address,Ref_cal_factor,Err)
3010  !
3020  ! 12/21/87:  Simple subroutine to CALIBRATE the 437B power meter.
3030  ! Ref_cal_factor = Input of REF CF in percent
3040  ! If Err=0, then CAL was successful.
3050  ! If Err=1, then CAL was unsuccessful.
3060  !
3070  OUTPUT Hpib_address;"CS"              !Clear SPOLL register
3080  Time_zero=TIMEDATE                    !Initialize time interval counter
3090  OUTPUT Hpib_address;"CL"&VAL$(Ref_cal_factor)&"EN"
3100                                        !Send the CAL command, reference
3110                                        !cal factor and ENTER
3120        I=1
3130        WHILE I                         !Cycle till Timeout, Routine finished
3140                                        !or measurement error occurs.
3150        Deltat=TIMEDATE-Time_zero       !Time to CAL
3160        Spval=SPOLL(Hpib_address)       !Check Status Byte
3170             IF Deltat>10 OR BIT(Spval,3) THEN
3180             Err=1                      !CAL unsuccessful
3190             I=0
3200             END IF
3210             IF BIT(Spval,1) THEN
3220             Err=0                      !CAL successful
3230             I=0
3240             END IF
3250        END WHILE
3260  SUBEND
3270  !
```

Comments

The REF CAL FACTOR, which is entered via CAL, is used only during calibration. Calibration factors entered via CAL. FAC are used for actual measurements. The REF CAL FACTOR can be found on the body of the power sensor.

Zero the Power Meter before calibration.

A calibration should be performed whenever the power sensor is changed or whenever the ambient temperature changes by more than 5° C.

PRESET sets REF CF to the REF CF value in the current Sensor Data table. The gain of the Power Meter, however, does not change until a new calibration is performed.

Pressing CAL and then ENTER without entering any data causes the Power Meter to initiate a calibration routine using the last entered value for REF CF.

Any command (front panel or HP-IB) that is received during the calibration routine aborts the calibration and executes the function of the command received. The number entered for REF CF, however, is stored as the last entered value. If the calibration is interrupted by a command, the calibration must be done again in order to ensure calibrated readings.

When using an older HP 8483A Power Sensor, enter a REF CAL FACTOR of 96%, even though 100% may be indicated on the sensor's cal factor label. Using this CAL value compensates for mismatch between the 75-ohm sensor and the 50-ohm reference oscillator. Newer HP 8483A Power Sensors have the correct reference cal factor (96% or less) printed on the label and should be used.

If an HP 8484A Power Sensor with its associated HP 11708A Reference Attenuator is used, the front panel display reads 1.000 μW instead of 1.000 mW.

Because of the variety of sensor power ranges, the Power Meter always auto ranges during calibration. After calibration the previous range setting is restored.

OFFSET, REL, and DUTY CYCLE settings are ignored during calibration.

Error 57 occurs when the instrument is turned on and the internal RAM contents have been lost. This is generally due to battery failure, but may also occur when the Power Meter is powered down during calibration or zeroing. The error is cleared after two seconds or by selecting any other function. Once the error is cleared, the Power Meter is configured to the PRESET state and the HP-IB address is set to 13.

When CAL is first pressed, the Meter will display "REF CF DDD.D%". The displayed value of REF CF is the value of the REF CF that is stored in the particular sensor data table that has been selected via the SENSOR key. The REF CF that is entered during CAL is not stored in the selected sensor data table. The REF CF in the sensor data table is permanently changed only through the SPECIAL key.

When the CAL function is used, the 50 MHz POWER REF oscillator is automatically enabled for the duration of the calibration routine. After CAL is finished, the POWER REF oscillator is returned to its previous state (either on or off).

CAL FAC

Description

The calibration factor compensates for mismatch losses and effective efficiency over the frequency range of the power sensor.

Pressing the CAL FAC key enables entry of the calibration factor of a specific power sensor at a specific input frequency. (A chart or table of CAL FACTOR % versus Frequency is printed on each sensor and an accompanying data sheet.) Calibration factor is entered in percent. Valid entries for CAL FACTOR range from 1.0 to 150.0%. Front panel numeric entry allows up to 4 digits. Only one digit to the right of the decimal point is accepted. Data entered over the HP-IB (in remote mode) is rounded to the required resolution.

Local Procedure

1. Press CAL FAC (SHIFTed FREQ). The Power Meter will display the last entered calibration factor with one digit blinking. (The Power Meter will display "CALFAC DDD.D%").

2. Modify the blinking digit (see below) until the desired calibration factor is displayed.

   a. Use [▲] or [▼] to modify the blinking digit.

   b. Use [◀] or [▶] to move to other digits.

3. Press ENTER.

Remote Procedure

The program code to enter a calibration factor is KB. To enter a calibration factor value, send the command KB followed by the calibration factor value and a terminator (%, PCT, or EN).

Example:

To enter a cal factor of 99%:

KB99.9%

HP-IB Program Codes

Parameter	Program Code
CAL FAC Percent ENTER	KB %, PCT EN

Comments

After a calibration factor has been ENTERed, the display returns to its previous mode.

The front panel displays the value of the calibration factor(s) used in the current measurement.

During actual measurements, calibration factors entered via CAL FAC are used. The reference calibration factor, which is entered via CAL, is only used during the calibration routine.

If CAL FAC and then ENTER is pressed without entering or modifying the displayed data, the Power Meter uses the value of the last entered calibration factor.

PRESET sets CAL FAC to the CAL FAC value in the current Sensor Data table.

Display

Description

The selection of display functions is available only via remote programming. During local operation, the Power Meter display is enabled to indicate measurement results, error codes, entries in progress, and instrument status. In remote mode, four display functions are allowed: display enable, display disable, display all, and display user message.

Local Procedure

The Power Meter is always in display enable mode when operating in local mode.

Remote Procedure

Four display functions are available: display enable, display disable, display all, and display user message.

Display Enable (DE). This function is identical to local operation and is the function in effect when no other display function has been selected. This is the display function at turn-on. This condition is also established by PRESET.

Display Disable (DD). This function blanks out the front panel display. All readings over the bus remain valid. This function is cleared by sending another display function program code or PRESET.

Display All (DA). This function causes the Power Meter to turn on all front panel display segments. It is used to verify that all display segments are working properly. This function is cleared by sending another display function program code or PRESET. (At turn-on, all the display segments are enabled momentarily before the display enable becomes active.)

Display User Message (DU). This function allows the user to output a message from the controller to the Power Meter's alphanumeric display. This message can be up to 12 characters long and can be composed of numbers (0-9), letters (A-Z), or blank spaces. For example: "DU CONNECT DUT".

HP-IB Program Codes

Parameter	Program Code
Display Enable	DE
Display Disable	DD
Display All	DA
Display User Message	DU

Comments

The reading displayed by the Power Meter is a combination of four elements: the measured input power plus any OFFSET values that have been entered into the Meter minus any REL (relative) measurement values minus any DUTY CYCLE values. A change in any of the factors will affect the Power Meter's front panel reading. If a power measurement appears incorrect, ensure that there is no incorrect OFFSET or REL value entered into the Power Meter. OFFSET is disabled by pressing SHIFT OFFSET. REL is disabled by pressing SHIFT REL.

DUTY CYCLE

Description

The DUTY CYCLE key allows entry of the duty cycle of a pulsed input signal. This function will cause the Power Meter to display the pulse power of a rectangular pulsed input signal. The allowable range of values for DUTY CYCLE is 0.001 to 99.999%.

Pulse power, as displayed by the Power Meter, is a mathematical representation of the pulse power rather than an actual measurement. The Power Meter measures the average power of the pulsed input signal and then divides the measurement by the duty cycle value to obtain a pulse power reading.

Local Procedure

1. Press the DUTY CYCLE key. The Power Meter will display the last duty cycle entered, with one digit blinking.
2. Modify the blinking digit (see below) until the duty cycle of the input signal is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
3. Press the ENTER key.
4. The Power Meter will now display pulse power.

Remote Procedure

The program code to turn the duty cycle function on is DC1. Use DC0 to turn the duty cycle function off.

The program code to enter a duty cycle value is DY. To enter a value, send the DY command followed by the numerical duty cycle value followed by the program code EN (ENTER), the percent sign (%), or the program code PCT (percent).

Example:

To enter a duty cycle value of 98.5%:

DY98.5EN or DY98.5% or DY98.5PCT

HP-IB Program Codes

Parameter	Program Code
DUTY CYCLE off	DC0
DUTY CYCLE on	DC1
Enter Duty Cycle value	DY
ENTER	EN
Percent	%, PCT

Comments

PRESET sets DUTY CYCLE to OFF, and the duty cycle value to 1.000%.

The Duty Cycle function can be turned on and off from the Power Meter's front panel without repeatedly entering the duty cycle value. Press SHIFT, followed by DUTY CYCLE to turn the Duty Cycle function on or off. When Duty Cycle is turned on with this method, the Power Meter uses the last entered value of DTYCY as the duty cycle value.

When the Duty Cycle function is activated, the DTY CY annunciator in the display is activated.

When DUTY CYCLE is pressed (followed by ENTER), the Power Meter will calculate pulse power of the input signal even if the signal is not being pulsed. This can lead to erroneous readings.

Care must be taken to ensure that the proper duty cycle value is entered into the Power Meter. When DUTY CYCLE is enabled, the Power Meter will calculate pulse power using the last entered duty cycle value. This can lead to erroneous readings. For example, if the Power Meter has been PRESET (which sets the duty cycle value to 1.000%), and then DUTY CYCLE is activated, the Power Meter will use 1.000% as the duty cycle value.

Pulse power averages out any aberrations in the pulse such as overshoot or ringing. For this reason it is called pulse power and not peak power or peak pulse power.

In order to ensure accurate pulse power readings, the input signal must be pulsed with a rectangular pulse. Other pulse shapes (such as triangle, chirp, or Gaussian) will cause erroneous readings.

ENTER

Description

The ENTER key is used:

a. To terminate numeric data entered into the Power Meter's front panel.

b. To access various levels of data entry of the SPECIAL key.

ENTER is used to set parameters of various functions of the Power Meter. Several functions of the Power Meter require a numerical data entry. After the numeric data is keyed into the display, pressing the ENTER key sets the function to the entered parameter.

If the ENTER key is not pressed after entering numeric data, (for example, if EXIT is pressed or another function is enabled), the previous function is aborted and the entered numeric data is lost.

The keys that require the use of the ENTER key are listed below:

CAL
OFFSET
STORE
RECALL
RESOLN
CAL FAC
FREQ
SET RANGE
SENSOR
SPECIAL
PRESET/LOCAL
DUTY CYCLE

Local Procedure

The example below demonstrates a typical use of the ENTER key when it is being used to set the parameters of a function.

Example:

To enter a frequency of 1.0 GHz:

1. Press FREQ. The Power Meter will display the previously entered frequency value with one blinking digit.

2. Modify the blinking digit (see below) until 1.0 GHz is displayed.

   a. Use [▲] and [▼] to modify the blinking digit.

   b. Use [◀] and [▶] to move to other digits.

3. Press ENTER.

The ENTER key is also used to access various levels of data entry while in the SPECIAL mode.

Example:

1. Press the SPECIAL (SHIFTed PRESET/LOCAL) key.
2. The Power Meter will display a blinking digit and a corresponding special function category title.
3. Using [▲] or [▼], modify the blinking digit until the desired category is displayed.
4. Press ENTER to select the desired category.

Remote Procedure

The program code for ENTER is EN. The EN code is used to terminate a string of numeric data in the Data message. To enter data, send the function command, followed by the numeric data, and terminated by the EN command.

The example below is typical of the use of the EN command.

Example:

To enter an offset of 3.0 dB:

```
OS3.0EN
```

HP-IB Program Codes

Parameters	Program Code
ENTER	EN

Comments

ENTER is used in the same manner as front panel keystroke entry; It is used to terminate numeric data.

If a function is accessed and then the ENTER key is pressed without entering (or changing) the numeric data, the Power Meter uses the previously entered data. If the Power Meter has been PRESET, the Power Meter will use the default value of the function. This also happens in remote when a function is enabled via an HP-IB command, and then followed by the command EN (with no numeric data).

EXIT

Description

The EXIT key is used to discontinue access to certain selected functions and the SPECIAL key functions. When the EXIT key is used, the Power Meter returns to standard measurement operation.

Functions that the EXIT key will discontinue access to are listed below:

SPECIAL and all SPECIAL functions
STORE
RECALL
SENSOR
SET RANGE
CAL FAC
RESOLN
CAL
DUTY CYCLE
FREQ
OFFSET
ZERO

Local Procedure

To discontinue access to a selected function, press EXIT (SHIFTed ENTER).

Remote Procedure

The program code for EXIT is EX. Use of this command while in SPECIAL mode will discontinue the SPECIAL mode and return the Power Meter to the standard measurement function. To exit Special mode, send the EX command.

The EXIT command is not necessary for any HP-IB function except table edit (ET). The table edit command allows the user to modify the data in the internal sensor data tables. When the edit table (ET) command is sent, the Power Meter moves into data entry mode. When in this mode all numeric data will be entered into the selected sensor data table until the EXIT (EX) command is received. For an example of how the EXIT command is used, see the Programming Example located in SENSOR DATA in this section.

HP-IB Program Codes

Parameter	Program Code
EXIT	EX

Comments

If a function key is pressed, and the EXIT key is pressed without entering any data, the function is aborted.

If a function key is pressed, numeric data entered, and the EXIT key is pressed (and ENTER is NOT pressed), the function is aborted and the entered numeric data is lost. The previous values of the function, however, are not changed.

Filter

Description

Note

The filter is accessed through the SPECIAL key.

The Power Meter uses a variable digital filter to average power readings. The number of readings averaged can range from 1 to 512 in binary progression.

The purpose of filtering is to reduce jitter in the display. When a new power measurement is input to the filter, it is saved and the oldest reading is discarded. If the Power Meter's configuration changes such that the values in the filter are no longer valid (for example, a change in measurement mode, range, or filter setting), the filter contents are set to zero. The filter starts storing values again, and the Power Meter displays the average of the accumulated power readings.

The number of readings averaged together by the Power Meter can be selected automatically or manually. For most applications, auto filter mode is the best mode of operation. Manual filter mode is useful mainly in specialized applications requiring high resolution or fast settling times.

In auto filter mode, the Power Meter automatically sets the number of readings averaged together to satisfy the filtering requirements for most power measurements. The number of readings averaged together depends upon the resolution and the power range in which the Power Meter is currently operating. The following table lists the number of readings averaged for each range and resolution when the Power Meter is in auto filter mode.

Number of Averages vs. Range and Resolution (Auto Filter Mode)

	Res 1	Res 2	Res 3
	Number of Averages	Number of Averages	Number of Averages
Range 1	8	128	128
Range 2	1	8	256
Range 3	1	2	32
Range 4	1	1	16
Range 5	1	1	8

When the resolution of the display is modified (using the RESOLN key), auto filter is automatically enabled.

In manual filter mode, the number of readings to be averaged is entered from the front panel via the SPECIAL key. The number of readings averaged is not affected by the measurement power range when set manually.

Local Procedure

Automatic Filter:

1. Press SPECIAL (SHIFTed PRESET/LOCAL).
2. Press ▲ or ▼ until the display reads "3 FILTER AVG".
3. Press ENTER.
4. Press ▲ or ▼ until the display reads "AUTO FILT ON".
5. Press ENTER.
6. to exit SPECIAL mode, press EXIT (SHIFTed ENTER).

Manual Filter:

1. Press SPECIAL (SHIFTed PRESET/LOCAL).
2. Press ▲ or ▼ until the display reads "3 FILTER AVG".

3. Press ENTER.
4. Press ▲ or ▼ until the display reads "MANL FILT ON".
5. Press ENTER. The display will read "DDD AVERAGES", where DDD indicates the number of readings to be averaged.
6. Press ▲ or ▼ until the meter displays the desired number of averages.
7. Press ENTER.
8. To exit SPECIAL mode, press EXIT (SHIFTed ENTER).

Remote Procedure

To select automatic filtering, send the command FA. No other command is necessary.

To select manual filtering and enter the number of readings to be averaged together, send the command FM followed by the filter length (up to 512 readings) and the code EN.

The number of readings the Power Meter averages together increase in binary progression (1, 2, 4, 8, 16, 32, 64, 128, 256, 512). If the number of readings entered via HP-IB is not one of these numbers, the Power Meter will automatically round the entry to the nearest allowable number of readings.

Example:

To set the manual filter to average 128 readings:

FM128EN

Program Codes

Parameter	Program Code
Automatic Filter	FA
Manual Filter	FM
Hold Filter	FH
ENTER	EN

Comments

As the number of readings to be averaged together increases, the settling time of the Power Meter increases. See the Supplemental Characteristics in Section I for a listing of the response times.

The SPCL annunciator on the front panel display is enabled when the Power Meter is in manual filter mode. Note, however, that the SPCL annunciator is enabled when any of the SPECIAL functions (such as Limits Checking) are activated. An enabled SPCL annunciator does not always indicate that the filter is in manual mode.

There is no front panel indication when the Power Meter is in auto filter mode.

In auto filter mode, the average of the last four values entered into the filter is compared to the average of the entire filter. If the difference between the two averages is greater than 12.5%, the contents of the digital filter are set to zero. The filter then starts storing new measurement values, and the Power Meter displays the average of accumulated power readings. This feature shortens the settling time of the Power Meter when the input power changes substantially.

An additional feature of the Power Meter is the hold filter mode. Hold filter mode provides a means of switching from auto filter mode to manual filter mode while retaining the auto filter setting.

When the Power Meter is addressed to listen and receives the program code FH (Filter Hold), it switches from auto filter mode to manual filter mode using the current auto filter value. If the Power Meter is already in manual filter mode when the FH code is received, no action is taken. No filter number is entered with this program code.

PRESET sets the Power Meter to auto filter mode.

FREQ

Description

The FREQ (frequency) key allows entry of the frequency of the input signal. Entering a frequency causes the Power Meter to select a sensor-specific calibration factor. The allowable range of FREQ values is from 0.0001 to 999.9999 GHz with a 100 kHz resolution.

When a frequency is entered via the FREQ key, the Power Meter accesses an internal table of calibration factors. This table of calibration factors is pre-programmed by the user for specific sensors. The sensor table should be selected using the SENSOR key prior to entering a frequency. When a frequency is entered, the Power Meter accesses the table of calibration factors for the power sensor that has been selected. If the entered frequency does not have a corresponding calibration factor in the selected table, the Power Meter uses linear interpolation to calculate one.

Local Procedure

1. Press the FREQ key. The Power Meter will display the last frequency entered, with one digit blinking. (If the Power Meter has been PRESET, the display will read "FR 000.0500GZ".)

2. Modify the blinking digit (see below) until the desired frequency is displayed.

   a. Use [▲] or [▼] to modify the blinking digit.

   b. Use [◀] or [▶] to move to other digits.

3. Press the ENTER key.

Remote Procedure

To enter a frequency value, send the command FR followed by the numerical frequency value, the frequency units code (GZ, MZ, KZ, or HZ).

Example:

To enter a frequency of 300 MHz:

FR300MZ

HP-IB Program Codes

Parameter	Program Code
FREQ	FR
GHz	GZ
MHz	MZ
kHz	KZ
Hz	HZ
ENTER	EN

Comments

PRESET sets the FREQ value to 000.0500 GHz.

The FREQ key allows the user to make calibrated power measurements without entering the calibration factor for each individual frequency measured. This is accomplished through the use of tables of calibration factors that are stored in the Power Meter's memory.

The Power Meter contains 10 tables in its memory for the storage of frequency versus calibration factor data. Each of these tables is identified by a unique number (0-9) and a user-defined ID. (To see an example of the ID, press the SENSOR key. The display will read "0 ID DEFAULT". The "0" is the sensor data table number, and "DEFAULT" is the ID) The ID is a label for the sensor data table that is defined by the user via the SPECIAL key.

When a frequency is entered via the FREQ key, the Power Meter accesses the table of sensor-specific calibration factors. In order for the Power Meter to access the proper table, the power sensor's ID must be selected using the SENSOR (SHIFTed [◄]) key before any power measurements are made. Entering an ID that doesn't match the sensor being used may result in possible incorrect readings.

Sensor calibration data is loaded into the Power Meter's tables using the SPECIAL key. For more information, see SENSOR DATA in this section.

If the user tries to access a table that contains no calibration factors, the Power Meter will send Error 80 over the HP-IB and display NO TBL DATA.

If the user doesn't select a sensor data table for the power sensor he is using, the Power Meter will default to the last selected sensor data table.

The FREQ key has a "scrolling" function for ease of frequency value selection. If the frequencies to be measured exactly match the frequencies that have been stored for the specific sensor, each individual frequency does not need to be entered. Pressing and holding the FREQ key down will cause the Power Meter display to advance to the next stored frequency value. When the desired frequency is displayed, pressing the ENTER key will enter the frequency.

If a frequency is entered that doesn't match any of the stored frequencies in the sensor's calibration factor table, the Power Meter mathematically derives a calibration factor using linear interpolation. If the entered frequency is above (or below) the table's range, the calibration factor associated with the highest (or lowest) stored frequency is used.

The Power Meter is programmed with calibration factors in all ten of its tables at the factory. The programmed calibration factor values are nominal values and can be changed. The values for tables 0 and 1 are stored in ROM in the Power Meter.

The data in tables 0 through 9 are programmed with calibration factors from the factory. Once the factory data in tables 2-9 is erased by the user it cannot be recovered. Data from table 1 (nominal values for the HP 8481A sensor) can be loaded from ROM into tables 1 through 9 using the procedure below:

1. Press SPECIAL (SHIFTed PRESET/LOCAL).
2. Press [▲] or [▼] until the Power Meter's display reads "1 SENSR DATA".
3. Press ENTER.
4. Press [▲] or [▼] until the desired sensor number (1-9) is displayed.
5. Press ENTER. The Power Meter will display the sensor's ID number.
6. Press ENTER. The Power Meter will display "CLR TBL ? N".

7. Use [▲] or [▼] to change "N" to "Y". Press the ENTER key.
8. Set the Power Meter's LINE switch to STBY.
9. Set the Power Meter's LINE switch to ON.
10. The table is now loaded with nominal calibration factors for the HP 8481A power sensor.

Note

This procedure loads individual tables only. It doesn't load all the tables simultaneously.

Limits

Description

Note

The Limits Checking Function is accessed through the SPECIAL key or HP-IB.

The limits checking function allows the Power Meter to monitor the power level at the sensor and to indicate when that power is outside preset limits. High and low limits can be set.

Limit values are entered in dBm only. Allowable values range from +299.999 to -299.999 dBm.

When the limits checking function is enabled, the Power Meter uses the last entered high and low limit values.

Local Procedure

1. Press SPECIAL (SHIFTed PRESET/LOCAL).
2. Press [▲] or [▼] until the display reads "2 LIMITS".
3. Press ENTER. The Meter will display the last status setting of the Limits function (either "LIMITS ON" or "LIMITS OFF").
4. Press [▲] or [▼] until the display reads "LIMITS ON".
5. Press ENTER. The meter will display the last entered low limit value with one blinking digit.
6. If a low limit is desired, modify the blinking digit (see below) until the desired limit is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
7. Press ENTER. The meter will display the last entered high limit value with one blinking digit.
8. If a high limit is desired, modify the blinking digit until the desired limit is displayed.

9. Press ENTER.

10. To exit SPECIAL mode, press EXIT (SHIFTed ENTER).

Remote Procedure

To turn the Limits function on (using the last entered limit values), send the command LM1. To turn the Limits function off, send the command LM0.

The program code to enter a high limit value is LH. To enter a high limit value, send the command LH followed by the limit value and the code EN (ENTER).

The Program code to enter a low limit value is LL. To enter a low limit value, send the command LL followed by the limit value and the code EN (ENTER).

Example:

To set a high limit value of +30.00 dBm:

LH30.00EN

HP-IB Program Codes

Parameter	Program Code
Low Limit	LL
High Limit	LH
Limits function on	LM1
Limits function off	LM0
ENTER	EN
EXIT	EX

Comments

If the limits checking function is enabled and the input power exceeds the high limit or is less than the low limit, the out-of-limits condition is indicated by the Error Message OVER LIMIT or UNDER LIMIT being displayed.

The out-of-limits condition can be indicated over the bus by setting the Service Request Mask to enable an out-of-limits condition to issue the Require Service Message, thus lighting the SRQ annunciator on the front

panel. The Error Codes returned over the HP-IB will be:

21 OVER LIMIT
23 UNDER LIMIT

For remote (HP-IB) applications that require monitoring for over or under limit conditions, bit 4 (Over/Under Limit) of the Status Byte can be used. When the measured input power is over or under the preset limit, bit 4 will be set true.

If the Status Byte is to be used to monitor an over or under limits condition, the program string to initiate a measurement should begin with the program code CS. This will clear any previous settings of bit 4 (Over/Under Limit) and avoid an incorrect indication.

PRESET disables the Limits checking function.

Limits are checked against the displayed power measurement. The displayed power measurement is calculated as:
Measurement (dB) + OFFSET (dB) - REL (dB) - DUTY CYCLE (dB).

If the limits checking function is enabled in remote mode and then the Power Meter is switched to local operation, the limits checking function remains enabled.

High and low limits can be STOREd and RECALLed.

The SPCL annunciator on the front panel display is enabled when the limits checking function is activated. Note, however, that the SPCL annunciator is enabled when any of the SPECIAL functions (such as manual filter mode) are activated. An enabled SPCL annunciator does not always indicate that the limits checking function is activated.

OFFSET

Description

Offset values can be entered into the Power Meter to compensate for signal gain or loss (for example, to compensate for the loss of a 10 dB directional coupler). Offsets are entered in dB. The allowable range of values is -99.99 to +99.99 dB in 0.01 dB increments. The offset (in dB) is added to the measured power according to the algorithm:
Display=Measured power (dB)+OFFSET (dB)-REL (dB)-DUTY CYCLE (dB).

Local Procedure

1. Press OFFSET. The Power Meter will display the last entered offset value with one blinking digit.
2. Modify the blinking digit (see below) until the desired offset value is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
3. Press the ENTER key.

Remote Procedure

To enable the offset function, send the command OF1. To disable the offset function, send the command OF0.

The program code to enter an offset value is OS. To enter an offset value, send the command OS followed by the offset value and the code EN (ENTER).

Example:

To enter an offset value of 10 dB:

```
OS10EN
```

HP-IB Program Codes

Parameter	Program Code
Enter OFFSET value	OS
Enable OFFSET	OF1
Disable OFFSET	OF2
ENTER	EN

Comments

When an offset is added to a measurement, the OFS annunciator on the front panel is enabled.

Pressing the OFFSET key and then the ENTER key without entering any data causes the Power Meter to add an offset to the display using the last entered offset value.

PRESET sets the offset value to 00.00 dB, and disables the OFFSET function.

The OFFSET function can be enabled or disabled from the Power Meter's front panel using the SHIFT key. If OFFSET is enabled, pressing SHIFT OFFSET will disable the OFFSET function. If OFFSET is disabled, pressing SHIFT OFFSET will enable the OFFSET function using the last entered offset value.

Note

When enabling the OFFSET function with the SHIFT key, ensure that the desired offset value is entered in the Power Meter. An incorrect value will result in erroneous readings.

A dB offset can be added to a sensor whose display is in Watts. The Power Meter automatically makes the correction for measurement units.

OFFSET values and mode (on or off) can be STOREd and RECALLed.

PRESET

Description

The PRESET key sets the Power Meter to a known state. Preset conditions are shown in the following table.

PRESET Conditions

Parameter	Condition
FREQ	50 MHz
RESOLN	0.01 dB
DUTY CYCLE	1.000%, Off
REL	0 dB, Off
OFFSET	0 dB, Off
PWR REF (Reference Oscillator)	Off
Range	AUTO
dBm/W	dBm
Low Limit	-90.000 dBm
High Limit	+90.000 dBm
Limit Checking	Off
Trigger Mode	Free Run
Group Trigger Mode	Trigger with Delay
Display Function	Display Enable

Local Procedure

To set the Power Meter to the conditions shown in the preceding table:

1. Press the PRESET/LOCAL key. The Meter will display "ENT TO PRESET".
2. Press the ENTER key.

Remote Procedure

The program code for PRESET is PR. To set the Power Meter to the preset conditions, send the PR command.

HP-IB Program Codes

Parameter	Program Code
PRESET	PR

Comments

PRESET does not affect the calibration factors stored in the sensor data tables.

The PRESET routine can be aborted by pressing EXIT (SHIFTed ENTER) before pressing the ENTER key.

PRESET has no effect on front panel storage registers 0 through 10. When PRESET is activated, the Power Meter is set to the conditions shown in the previous table. Front panel storage register 0, however, retains the configuration of the Power Meter immediately previous to being PRESET. If the Power Meter is accidentally PRESET, the previous front panel configuration can be recovered using RECALL 0.

PWR REF

Description

The PWR REF key (SHIFTed [▶]) provides a stable 50 MHz, 1 mW signal at the POWER REF output connector on the front panel. PWR REF is used to calibrate the power sensor to the Power Meter.

When Option 003 is installed, the 50 MHz signal is provided at the REF OSC output on the Power Meter's rear panel.

Local Procedure

1. Press PWR REF (SHIFTed [▶]) to turn the 50 MHz reference oscillator on. When PWR REF is enabled, the PWR REF annunciator on the Power Meter's display is enabled.

2. When PWR REF is enabled, press PWR REF again to disable the 50 MHZ oscillator.

Remote Procedure

To enable the oscillator, send the program code OC1. To disable the oscillator, send the program code OC0.

HP-IB Program Codes

Parameter	Program Code
Disable 50 MHz oscillator Enable 50 MHz oscillator	OC0 OC1

Comments

PRESET disables the 50 MHz reference oscillator.

If the 50 MHz oscillator is enabled, the ZERO function will automatically disable it for the duration of the zeroing routine. When zeroing is finished, the 50 MHz oscillator will be re-enabled.

When the CAL function is used, the 50 MHz oscillator is automatically enabled for the duration of the calibration routine. If the oscillator is disabled when the CAL function is activated, the oscillator will be enabled for the duration of the CAL routine. The oscillator will then be disabled. If the user wishes to check the calibration of the Power Meter, the oscillator must be enabled using the PWR REF (SHIFTed [▶]) key or an HP-IB command.

The setting of the 50 MHz oscillator (enabled or disabled) can be STOREd and RECALLed in the storage registers.

RECALL

Description

The Power Meter can store instrument configurations for recall at a later time. The following information can be stored in the Power Meter's internal registers:

REF CF value
Measurement units (dBm or watts)
REL value and status (on or off)
PWR REF status (on or off)
CAL FAC value (Calibration Factor)
SENSOR ID and table number
OFFSET value and status (on and off)
RANGE (Auto or SET)
Filter (number of readings averaged, auto or manual)
DUTY CYCLE value and status (on or off)
FREQ value
RESOLN
Limits value and status (on or off)

Registers 0 through 10 are available for recall. Register 0 always contains the previous Power Meter configuration. Thus, RECALL 0 provides a way to recover from an entry error.

Local Procedure

To recall an instrument configuration:

1. Press RECALL (SHIFTed ▲). The Power Meter will display "RECALL 00" with one of the digits blinking.
2. Modify the blinking digit until the desired storage register is displayed.
3. Press ENTER.

Remote Procedure

To recall an instrument configuration from a specific storage register, send the command RC followed by the storage register number and the code EN (ENTER).

Examples:

To recall an instrument configuration that has been stored in register 2:

```
RC2EN
```

HP-IB Program Codes

Parameter	Program Codes
RECALL ENTER	RC EN

Comments

Whenever RECALL is accessed, the first available register will always be register 0.

The Power Meter executes a RECALL 0 at power-up. This places the Power Meter in the same state that it was in when power was removed.

The REF CF value (reference calibration factor) for the power sensor can be stored and recalled but the internal calibration settings are not stored.

PRESET has no effect on the storage registers 0 through 10. Register 0 retains the configuration of the Power Meter immediately previous to being PRESET. If the Power Meter is accidentally PRESET, the previous front panel configuration can be recovered using RECALL 0.

All storage registers are set to the PRESET state when a RAM ID check error (error 57) occurs.

REL

Description

Relative mode permits any measurement result to be compared in dB or percent (%) to a reference value. Pressing the REL key enters relative mode. Once relative mode has been entered, the displayed value is saved as a reference value. Successive measurements are displayed relative to the reference value.

Whenever the REL key is pressed the Power Meter uses the current reading as the reference value.

The REL mode can be disabled and re-enabled without losing the previous stored reference value. Pressing SHIFT REL (when REL is disabled) will enable REL mode without establishing a new reference value.

The relative reading can be displayed in either dB or percent (%) by pressing the dBm/W key.

Local Procedure

Press REL to enable REL mode using the current display reading as the reference value.

Press SHIFT REL to enable REL mode with the last stored reference value.

Remote Procedure

The program code to enter relative mode is RL. Relative mode has three relevant commands. These are explained below.

RL0 disables REL mode.

RL1 enables REL mode using the CURRENT displayed reading as the reference.

RL2 enables REL mode using the LAST entered reference power level (from a previous REL mode) as the reference.

Example:

To enter relative mode and make relative measurements using the CURRENT power reading:

```
RL1
```

HP-IB Program Codes

Parameter	Program Codes
Disable REL mode	RL0
Enable REL mode using the CURRENT power reading	RL1
Enable REL mode using the PREVIOUS reference level	RL2

Comments

Relative measurements cannot be output via the rear panel RCDR output.

The REL reference value, once set, cannot be read directly. The value can be computed, however, by taking the difference between two readings: one reading with REL on, and one reading with REL off.

PRESET disables REL mode and sets the reference value to 0.0.

REL value and status (on or off) can be STOREd and RECALLed.

RESOLN

Description

The RESOLN (SHIFTed dBm/W) key is used to adjust the resolution of the Power Meter's display. Three levels of resolution can be set: 0.1 dB, 0.01 dB, and 0.001 dB (in watts mode, 1%, 0.1%, and 0.01% of full scale). The resolution can be set in both the dBm and watts mode.

Local Procedure

1. Press the RESOLN (SHIFTed dBm/W) key. The Power Meter will display the current resolution with one blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the desired resolution is displayed.
   a. RES1 = 0.1 dB (log), 1% full scale (linear).
   b. RES2 = 0.01 dB (log), .1% full scale (linear).
   c. RES3 = 0.001 dB (log), .01% full scale (linear).
3. Press the ENTER key.

Remote Procedure

To select a display resolution, send the command RE followed by the resolution number (1-3) and the code EN (ENTER).

Example:

To select resolution 2 (0.01 dB):

```
RE2EN
```

HP-IB Program Codes

Parameter	Program Codes
RESOLN ENTER	RE EN

Comments

PRESET sets RESOLN to RES2.

RESOLN uses only the [▲] and [▼] keys. The [▶] and [◀] keys are ignored.

Setting the resolution causes the Power Meter to average together several power readings. The finer the resolution set, the larger the number of readings that are averaged together. The larger number of readings slows the Power Meter's response time.

When the Power Meter is in auto filter mode, setting the resolution with the RESOLN key causes the Meter to average together the least number of readings in order to achieve a stable reading at the desired resolution.

When the Power Meter is in manual filter mode, changing the number of readings averaged together does not change the resolution.

SENSOR

Description

The SENSOR key is used to select the sensor data table corresponding to the power sensor that is being used. This function allows the FREQ key to access the proper table of calibration factors for the indicated power sensor.

Local Procedure

1. Press the SENSOR (SHIFTed [◄]) key. The Power Meter will display the last entered sensor data table number with one blinking digit (0-9).
2. Use [▲] or [▼] to modify the blinking digit until the desired sensor data table number is displayed.
3. Press the ENTER key.

Remote Procedure

To select a sensor data table, send the command SE followed by the table number (0-9) and the ENTER code (EN).

Example:

To enter the command for sensor #5:

SE5EN

HP-IB Program Codes

Parameter	Program Code
SENSOR ENTER	SE EN

Comments

When a sensor data table is being selected, the ◀ and ▶ keys are ignored by the Power Meter.

The tables of calibration factors can be modified by the user via the SPECIAL key. For more information, see Sensor Data in this section.

If a sensor data table is selected for which there are no calibration factors loaded into the tables, the Power Meter will display "NO TBL DATA". The user should select a different sensor data table, load calibration factors into the sensor data table (using the SPECIAL key), or enter a calibration factor using the CAL FAC key.

The ten sensor data tables are loaded with calibration factors at the factory. The data in the tables are statistical averages of calibration factors for a specific model of Hewlett-Packard power sensor. The sensor data table numbers and specific sensors are listed below.

Sensor Data Table	Power Sensor
Table 0	Default (100% for all frequencies)
Table 1	HP 8481A
Table 2	HP 8482A,8482B, 8482H
Table 3	HP 8483A
Table 4	HP 8484A, 8484A Opt. 001
Table 5	HP 8485A
Table 6	HP R8486A
Table 7	HP Q8486A
Table 8	HP R8486D
Table 9	HP 8487A

Sensor Data

Description

Note

The Sensor Data tables are accessed through the SPECIAL key or HP-IB only.

Sensor Data is a function of the SPECIAL key that allows the user to enter tables of calibration factors for specific power sensors into the Power Meter's memory.

Calibration factors are entered into the Sensor Data tables in frequency/calibration factor pairs. These frequency/calibration factor pairs are entered into the tables from the graph (or table) of calibration factors printed on the side of the power sensor.

When the Sensor Data tables are loaded with calibration factors, the user has the option of marking the table with a specific ID corresponding to the power sensor from which the calibration factors were taken. When the table of calibration factors is to be accessed, the power sensor's ID is entered via the SENSOR key.

The Power Meter's memory contains space for 10 tables, numbered 0-9. Tables 0-7 each contain space for 40 frequency/calibration factor pairs. Tables 8 and 9 each contain space for 80 frequency/calibration factor pairs.

The Power Meter's Sensor Data tables are loaded with calibration factors at the factory with typical values for specific HP power sensors. This data can be kept, modified, or erased by the user.

Local Procedure

To enter calibration factors into Sensor Data table #2:

1. Press the SPECIAL (SHIFTed PRESET/LOCAL) key. The Power Meter will display a SPECIAL function title and a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the Power Meter displays "I SENSR DATA".
3. Press the ENTER key. The Power Meter will display "SENSOR 0", with the "0" blinking.
4. Use [▲] or [▼] to modify the blinking digit until the display reads "SENSOR 2".

5. Press the ENTER key. The Power Meter will display "2 ID DDDDDDD", with one digit blinking ("D" represents any alphanumeric character). At this point the user can enter an ID label for the table consisting of 0-9, A-Z, or an underscore.

6. Modify the displayed ID number (if desired) until the desired power sensor ID label is displayed.

   a. Use [▲] and [▼] to modify the blinking digit.

   b. Use [◀] and [▶] to move to other digits.

7. Press the ENTER key. The Power Meter will display "CLR TBL ? N", with the "N" blinking.

8. If you want the Sensor Data table cleared of all previous entries (except REF CF), change "N" to "Y" (using the [▲] key). If you don't want the Sensor Data table cleared, leave this option "N".

Note

If data tables 2-9 are cleared, the data that is currently stored in them cannot be recovered.

9. Press the ENTER key. The Power Meter will display "REF CF DDD.D%". SCREEN MODE TRAILER LINE

10. Read the REF CAL FACTOR from the power sensor. Modify the REF CF value until the power sensor's REF CAL FACTOR is displayed.

11. Press the ENTER key. The Power Meter will display a frequency in the left side of the display and a calibration factor (in percent) in the right side.

12. Read the first frequency/calibration factor pair from the table (or graph) on the power sensor. Modify the Power Meter's display (see below) until the power sensor's frequency/calibration factor pair is displayed.

    a. Use [▲] and [▼] to modify the blinking digit.

    b. Use [◀] and [▶] to move to other digits.

Note

SHIFTed [◀] and SHIFTed [▶] will move the decimal point left or right. The decimal point can be moved only when entering a frequency value into the Sensor Data tables.

13. Press the ENTER key. This will store the frequency/calibration factor pair in the Sensor Data table and advance the table to the next frequency/calibration factor pair.

14. Continue entering frequency/calibration pairs as described above. When all data is entered, press the ENTER key.

15. Press the ENTER key. (When the entered frequency is 0.000 GHz, the Power Meter will move out of the data entry mode).

16. To leave the SPECIAL mode, press the EXIT (SHIFTed ENTER) key.

The user can modify any of the data in the Sensor Data tables at any time and from any position in the table. Three methods of modification are available to the user: inserting, deleting, and changing data. Their implementation is listed below:

Inserting data.

1. Access the desired Sensor Data table (via the SPECIAL key).

2. Use [▲], [▼], [▶], or [◀] to modify the displayed frequency and calibration factor until the desired frequency/calibration factor pair is shown.

3. Press the ENTER key.

Upon pressing the ENTER key, the Power Meter will store the new frequency/calibration factor pair in the table according to the frequency value (all current data will be retained). When the table is full, new data will not be stored and the meter will display "TABLE FULL" when the ENTER key is pressed.

Deleting data.

1. Access the desired Sensor Data table (via the SPECIAL key).

2. Locate the frequency/calibration factor pair to be deleted.

3. Use [▲], [▼], [▶], or [◀] to set the frequency to 0.00 GHz.

4. Press the ENTER key.

Changing calibration factor data at a specific frequency.

1. Access the desired Sensor Data table (via the SPECIAL key).

2. Locate the frequency/calibration factor pair to be changed.

3. Use [▲], [▼], [▶], or [◀] to change the calibration factor.

4. Press the ENTER key.

If the calibration factor is changed without changing the frequency, the old frequency/calibration factor pair is deleted and the new frequency/calibration factor pair is stored in its place. If the calibration factor and the frequency is changed, the old data will be retained and the new data will be stored in the table according to the frequency value.

When the maximum number of frequency/calibration factor pairs is entered into a Sensor Data table, the Power Meter will exit data entry mode when the ENTER key is pressed.

The values entered into the Sensor Data tables can be easily be reviewed for accuracy by using the Power Meter's "scrolling" function. When entering data into a Sensor Data table, pressing SHIFT [▲] will display the last entered frequency/calibration factor pair. Pressing SHIFT [▼] will display the next frequency/calibration factor pair.

Remote Procedure

There are several HP-IB program codes that affect the Sensor Data tables. These codes are listed below.

SN. This code allows the user to set a particular power sensor's ID label. table to be modified. To set an ID label, send the command SN followed immediately by the sensor number (0-9) and the sensor ID label (0-9, A-Z or an underscore). The sensor ID label must not exceed 7 characters. For example, to identify Sensor Data table #2 with an ID number of 1234567:

SN21234567

CT0-CT9. These codes allow the user to clear the Sensor Data table previous to entering new values. To clear a table, send the command CT followed immediately by the table number to be cleared. For example, to clear the data from Sensor Data table #3:

CT3

RF. This code allows the user to enter the power sensor's REF CAL FACTOR into the Sensor Data table. To enter a REF CAL FACTOR, send the command RF followed immediately by the Sensor Data table number, the REF CAL FACTOR, and the percent sign (%) or the code EN (ENTER). For example, to enter a REF CAL FACTOR of 98.5% for Sensor Data table #3:

RF398.5%

ET. This code allows the user to edit any of the Sensor Data tables. To edit a table, send the command ET followed immediately by the Sensor Data number. For example, to edit Sensor Data table #3:

```
ET3
```

Frequency/calibration factor data pairs can be entered into the Power Meter's Sensor Data table after the ET command is sent. The data can be sent in pairs and with appropriate units after each numeric data entry (frequency can be sent in Hz (HZ), kHz (KZ), MHz (MZ), or GHz (GZ). Calibration factors must be sent in percent (%)). Each data pair must be terminated with the program code EN (ENTER). For example, to enter a frequency of 1.00 MHz and a calibration factor of 98.5% into Sensor Data table #3:

```
ET3 1.00MZ 98.5% EN
```

HP-IB Program Codes

Parameter	Program Code
Clear Table	CT
Edit Table	ET
REF CF (For Sensor Data tables)	RF
Sensor ID	SN
ENTER	EN
EXIT	EX
Percent	%,PCT

Programming Examples

The following two programs are written in BASIC 5.0 for the HP 9000 series 200 or 300 controllers. The first program loads frequency/calibration factor pairs into the Power Meter. The second program reads the REF CF and frequency/calibration factor data from a user-selected Sensor Data table.

```
10    !
20    !                          PROGRAM SMPLUPLOAD
30    !
40    !              437B Cal Factor vs Frequency Upload Program
50    !                           November 30, 1987
60    !
70    !     This program uploads sensor table data into a 437B power meter.
80    !
90    DIM Frequency_mhz(1:80)                ! Maximum Frequency array(MHz)
100   DIM Cal_factor(1:80)                   ! Maximum Cal Factor array(percent)
110   !                               EXAMPLE
120   !                   Frequency,Cal Factor (15 Data Pairs).
130   !
140   DATA 0.1,99.8,0.9,99.6,4.6,98.4,10.05,98.1,50.34,97.5           !5 pairs
150   DATA 99.99,96.7,110.4,96.5,876.5,95.4,999.9,92.5,1006,90.4      !5 pairs
160   DATA 2000,90.0,4000,89.9,8000,89.7,12400,89.3,18000,89.0        !5 pairs
170   !
180                       ! START OF MAIN PROGRAM
190   Upperlimit=15
200   Sensor=1                          ! Number of the sensor table to be edited.
210   Id$="SN_4567"                     ! Sensor ID,7 characters max (Keep upper case)
220   Tablenum$=VAL$(Sensor)            ! Form ASCII 0-9 for table number
230   Ref_cal_factor=100.0              ! Reference  Cal Factor.
240   FOR N=1 TO Upperlimit             ! Read the 15 element pairs in data statements
250   READ Frequency_mhz(N),Cal_factor(N)       ! Read Frequency/Cal factor pair.
260   NEXT N
270   !
280   OUTPUT 713;"SN";Tablenum$;Id$          ! Set the sensor's identification
290   OUTPUT 713;"CT";Tablenum$              ! Clear the table, send CTx
300   OUTPUT 713;"RF";Tablenum$;Ref_cal_factor;"%"  !Ref cal factor.
310   OUTPUT 713;"ET";Tablenum$              ! Edit table 1 data, Send ETx
320   FOR N=1 TO Upperlimit
330      OUTPUT 713;Frequency_mhz(N);"MZ"    ! Output frequency in MHz
340      OUTPUT 713;Cal_factor(N);" %"       ! Output cal factor in percent
350      OUTPUT 713;"EN"                     ! Enter the data pair
360   NEXT N
370   OUTPUT 713;"EX"                        ! Leave table edit, save data
380   END
```

Reading the Sensor Data table:

The following program allows the controller to read and display the REF CF and frequency/calibration factor pairs in a user-selected Sensor Data table.

```
10    !  PROGRAM 'READ_TABLE'
20    !
30    DIM F(100),C(100)
40    Table_number=1
50    FOR I=0 TO 9
60    ON KEY I LABEL " " GOSUB Beep
70    NEXT I
80    ON KEY 0 LABEL "TABLE #" GOSUB Table_number
90    ON KEY 4 LABEL "READ" GOSUB Readtable
100   I=1
110   WHILE I
120   END WHILE
130   !
140 Readtable:   !
150         CALL Read_table(713,Table_number,Ref_cf,F(*),C(*),A,Err)
160         IF Err=1 THEN
170         PRINT "Error when attempting to read Table # ";Table_number
180         ELSE
190         PRINT "Reading Table #";Table_number
200         PRINT "Ref_cf = ";Ref_cf
210             IF A>0 THEN
220             FOR I=1 TO A
230             PRINT I,F(I),C(I)
240             NEXT I
250             ELSE
260             PRINT "NO TABLE DATA"
270             END IF
280         END IF
290         RETURN
300  !
310 Table_number:  !
320         BEEP
330         INPUT "READ WHAT TABLE #?",Table_number
340         RETURN
350  !
360 Beep:  BEEP
370         RETURN
380   END
3000  SUB Read_table(Hpib_address,Table_number,Ref_cf_pct,Freq_hz(*),
Cal_factor_pct(*),Array_length,Err)
3010  !
3020  ! 12/21/87 A simple subroutine to read a particular Sensor Table's
3030  !          Reference Cal-Factor and Cal Factor vs Frequency data.
3040  !
3050  ! Table_number   = Sensor table to be read ( Must be 0 to 9 )
3060  ! Ref_cf_pct     = Table Reference Cal-Factor in percent
3070  ! Freq_hz        = Table frequency array in Hz
3080  ! Cal_factor_pct = Table cal-factor array in percent
3090  !
3100  ! Err=0 if arrays read successfully
3110  ! Err=1 if arrays not read successfully
```

```
3120  DIM Display$[14],X$[ 1]
3130  INTEGER I,Array_max
3140  IF Table_number>9 OR Table_number<0 THEN
3150  Err=1                          !Table request exceeds Range.
3160                                 !Set Err to True
3170  ELSE
3180  X$=VAL$(Table_number)          !Convert to ASCII
3190  OUTPUT Hpib_address;"RF"&X$&"OD"!Select  Ref CF
3200  ENTER Hpib_address;Display$    !Ref_cf_pct
3205  Ref_cf_pct=VAL(Display$[8,12])
3210  !
3220  OUTPUT Hpib_address;"ET"&X$    !Select and edit Sensor Table
3230       IF Table_number<8 THEN
3240       Array_max=40              !For Tables<8, the maximum=40
3250       ELSE
3260       Array_max=80              !For Tables 8&9, the maximum=80
3270       END IF
3280  I=0                            !Initialize Array index
3290       WHILE I<Array_max
3300       OUTPUT Hpib_address;"OD"  !Read Display in ASCII
3310       ENTER Hpib_address;Display$
3320       Freq=VAL(Display$[1,5])   !4 digits and decimal point
3330       X$=Display$[6,6]          !Get the frequency units
3340            IF X$="M" THEN       !Units are Megahertz
3350            Units=1000000
3360            ELSE
3370            Units=1000000000     !Units are Gigahertz
3380            END IF
3390       Calfactor=VAL(Display$[9,13])   !4 digits and decimal point
3400       IF Freq>0 THEN
3410       I=I+1                     !Increment the array index
3420       Freq_hz(I)=Freq*Units     !Convert to Hz and save data
3430       Cal_factor_pct(I)=Calfactor
3440       OUTPUT Hpib_address;"EN"  !Go to next table value
3450            IF I=Array_max THEN
3460            Array_length=Array_max!Array at physical end.
3470            I=81                 !Terminate WHILE loop
3480            END IF
3490       ELSE                      !Array data done
3500       Array_length=I            !Save the Array length
3510       I=81                      !Terminate WHILE loop
3520       END IF
3530       END WHILE
3540       Err=0                     !Table read successfully. Set Err False
3550   END IF
3560   OUTPUT Hpib_address;"EX"      !Exit SPECIAL key

                    3570  SUBEND
```

Comments

PRESET does not affect the information in the Sensor Data tables.

The calibration data in Sensor Data tables 0 and 1 is stored in ROM and transferred to RAM. Once in RAM, the data in these tables can be modified in the same manner as the other tables. Table 0 is a default table. Table 1 contains typical calibration data for the HP 8481A power sensor.

When the 437B LINE switch is set to ON or the INIT function is enabled, a check for errors in each Sensor Data table is performed. If an error is found in a table, (the probability for an error is very remote), the table is cleared of all data and the REF CF for that table is set to 100%. If the user attempts to select the cleared table from the front panel, the Power Meter displays "NO TBL DATA".

The calibration data in Sensor Data tables 2-9 are pre-loaded in the factory with typical data for specific HP power sensors. The data can be kept, modified, or erased by the user. The data for these tables is stored only in RAM. If it is erased, it cannot be recovered. It is recommended that tables 2-9 are used first for storage of new data as tables 0 and 1 are reloaded with default data when Error 57 occurs.

Typical calibration factors for the 8481A power sensor can be placed in Sensor Data tables 1-9. This feature is advantageous if typical values of calibration data are desired in any of the other Sensor Data tables. An example of the procedure is shown below:

EXAMPLE: To enter typical calibration factors for the HP 8481A power sensor into table 3:

1. Press the SPECIAL (SHIFTed PRESET/LOCAL) key.
2. Use [▲] or [▼] to modify the display until the Power Meter displays "1 SENSR DATA".
3. Press the ENTER key. The Power Meter will display "SENSOR 0" with the 0 blinking.
4. Use [▲] or [▼] to adjust the blinking digit until "SENSOR 3" is displayed.
5. Press the ENTER key. The Power Meter will display "3 ID DDDDDDD" with one digit blinking.

6. If a new power sensor ID is desired, modify the blinking digit (see below) until the desired ID number is displayed.

   a. Use [▲] and [▼] to modify the blinking digit.

   b. Use [◀] and [▶] to move to other digits.

7. Press the ENTER key. The Power Meter will display "CLR TBL ? N" with the N blinking.

8. Use [▲] to change the N to Y.

9. Press the ENTER key. Do NOT press any other keys.

10. Set the Power Meter's LINE switch to STBY.

11. Set the Power Meter's LINE switch to ON. Table #3 will be loaded automatically with the HP 8481A typical calibration factors from ROM.

Note

If "SENSOR 0" is selected in this procedure, Sensor Data table 0 will be loaded with default values (100% calibration factor for all frequencies).

SET RANGE

Description

The Power Meter divides each sensor's power range into 5 ranges of 10 dB each. Range 1 is the most sensitive (lowest power levels), and Range 5 is the least sensitive (highest power levels). The range can be set either automatically or manually.

SET RANGE enables the range to be selected manually. Valid range numbers are 0 through 5 (range 0 selects auto range mode).

When SET RANGE is used, the Power Meter enters the Range Hold mode. The range will remain at its current setting no matter what level of power is applied to the sensor. To exit from Range Hold, press AUTO RNG (SHIFTed SET RANGE).

Local Procedure

To manually select a range:

1. Press SET RANGE. The Meter will display the current range setting with a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the desired range is displayed.
3. Press the ENTER key.

Remote Procedure

To enable the manual range function, send the command RM followed by the range number (0-5) and the code EN (ENTER).

Example:

To select range 3:

```
RM3EN
```

HP-IB Program Codes

Parameter	Program Codes
SET RANGE Hold Range ENTER	RM RH EN

Comments

The RNG HLD annunciator on the front panel display is enabled when the Power Meter is in SET RANGE mode.

PRESET sets the Power Meter to AUTO RNG.

If you are only interested in power readings in one range, SET RANGE can be used for faster readings.

Use manual range when using the rear panel RCDR output so that the Power Meter does not change ranges while outputting data. The recorder output provides a 0 to 1 V dc output for each range.

If the input power to the sensor is too high for the range, the Power Meter will display "UP RANGE". To remedy the problem, select a higher power range, reduce the input power to the sensor, or use the AUTO RNG selection.

SPECIAL

Description

The SPECIAL key is used to access a group of operations. These operations are listed below.

Special Status
Sensor Data
Limits
Filter Averaging
HP-IB Address
Self Test
Init (Initialize)

Special Status, HP-IB Address, Self Test, and Init will be discussed in this section. Sensor Data, Limits, and Filter Averaging are discussed in the Detailed Operation Instructions under their own heading.

There are two levels of operation when in SPECIAL mode:

a. Level 1, which allows the user to view and access the operations listed above.

b. Level 2, which allows the user to modify or review the settings of the parameters of the operations.

Level 1 is accessed by pressing the SPECIAL (SHIFTed PRESET/LOCAL) key. Level 2 is accessed by pressing the ENTER key after a level one operation is selected. At the end of a level 2 operation the ENTER key will return the user to level one.

Local Procedure

Note

The following is a general procedure to access the SPECIAL mode and select a level 2 operation. Detailed instructions to access specific level 2 operations will be covered in later paragraphs.

To access the special mode:

1. Press the SPECIAL (SHIFTed PRESET/LOCAL) key. The Power Meter will display an operation title with a blinking digit.

2. Use [▲] or [▼] to modify the blinking digit until the desired operation title is displayed.

3. Press the ENTER key to access the desired operation.

Remote Procedure

The program code for SPECIAL is SP. To enable the SPECIAL mode, send the command SP followed by the desired function, any necessary parameters, and the EN (ENTER) command.

It is not necessary to use the SPECIAL command to access the SPECIAL operations. All of the operations in SPECIAL mode have their own HP-IB codes.

HP-IB Program Codes

Parameter	Program Code
SPECIAL ENTER	SP EN

Comments

The arrow keys have two functions when the Power Meter is in SPECIAL mode: the regular function and the SHIFTed function.

The regular function of the arrow keys (when in SPECIAL mode) is the same as when the Power Meter is not in SPECIAL mode: they modify numeric data input.

There are two SHIFTed functions:

1. SHIFTed [▲] and [▼] will "scroll" the data in the display. SHIFTed [▲] will allow the user to return to the previous display, SHIFTed [▼] will allow the user to advance to the next display. This function is advantageous when data is being entered into the Sensor Data tables.

2. SHIFTed [◀] and [▶] will move the decimal point of displayed numeric data left or right when entering frequency/calibration factor pairs into the Sensor Data tables. The decimal point can be moved only when entering a frequency value into the Sensor Data table.

When in level 2 of the SPECIAL mode, the usual SHIFTed functions of the arrow keys (STORE, RECALL, SENSOR, and PWR REF) are disabled.

The ENTER key selects the displayed level 1 operation and moves the Power Meter to level 2.

The EXIT (SHIFTed ENTER) key takes the Power Meter out of SPECIAL mode.

Note

The following paragraphs describe how to access and/or modify four of the SPECIAL operations; SPECIAL STATUS, HP-IB ADDRESS, SELF TEST, and INIT. The other SPECIAL operations (SENSOR DATA, LIMITS, and FILTER Averaging) are described under separate headings in the Detailed Operating Instructions.

SPECIAL STATUS

Description

SPECIAL STATUS describes the current operating mode of the functions available in SPECIAL mode.

Local Procedure

To access SPECIAL STATUS:

1. Press the SPECIAL (SHIFTed PRESET/LOCAL) key. The Power Meter will display a SPECIAL title with a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the display reads "0 SPL STATUS".
3. Press the ENTER key.

Subsequent pressings of the ENTER key will display the status of the SPECIAL functions. When all of the functions have been displayed, the display will read "0 SPL STATUS". Press the EXIT (SHIFTed ENTER) key to leave the SPECIAL mode.

The functions that are displayed under SPECIAL STATUS are as follows: ("DDD" indicates a numeric digit.)

SENSOR D
LIMITS (ON or OFF)
AUTO FLT DDD or MANL FLT DDD
HPIB ADRS DD
SOFTWARE D.D

In the FLT (Filter) display, the "DDD" indicates the number of readings being averaged together.

Remote Procedure

There is no remote procedure to check the SPECIAL STATUS. LIMITS and FILTER status can be checked using the Status Message.

HP-IB ADDRESS

Description

HP-IB ADDRESS allows the user to modify the HP-IB address of the Power Meter.

Local Procedure

To modify the HP-IB ADDRESS:

1. Press the SPECIAL (SHIFTed PRESET/LOCAL) key. The Power Meter will display a SPECIAL operation title with a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the display reads "4 HP-IB ADRS".
3. Press the ENTER key. The Power Meter will display "ADDRESS DD" with one blinking digit.
4. Modify the blinking digit (see below) until the desired HP-IB address is displayed.
   a. Use [▲] and [▼] to modify the blinking digit.
   b. Use [◀] and [▶] to move to the adjacent digit.
5. Press the ENTER key.
6. To leave the SPECIAL mode, press the EXIT (SHIFTed ENTER) key.

Remote Procedure

There is no remote procedure to set the HP-IB address.

Comments

Valid HP-IB address entries are 0-30, 40 (listen only), 50 (talk only).

SELF TEST

Description

The SELF TEST function causes the Power Meter to initiate the internal tests that are performed when the instrument is first turned on. The tests are listed below:

Read Only Memory (ROM)
Random Access Memory (RAM)
Analog-to-Digital Converter (ADC)
Display
Keyboard

When the SELF TEST function is accessed a full test (all tests except the keyboard test) can be performed, or the tests can be performed separately.

Note

When the keyboard test is performed, the front panel keys will no longer perform their indicated functions. The only way to restore the Power Meter to regular measurement mode is to set the LINE switch to STDBY, then ON.

Local Procedure

1. Press the SPECIAL (SHIFTed PRESET/LOCAL) key. The Power Meter will display a SPECIAL function with a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the display reads "5 SELF TEST".
3. Press the ENTER key. The Power Meter will display "TEST 0-ALL".
4. If the full set of self tests is desired, press the ENTER key.
5. If a single test is desired, use [▲] or [▼] to select the desired test.
6. Press the ENTER key.
7. To leave the SPECIAL mode, press the EXIT (SHIFTed ENTER) key.

Remote Procedure

There is no remote procedure to perform the Self Tests.

Comments

The results of the full test, the ROM test, the RAM test, and the ADC test are displayed on the right side of the Power Meter's display when the test is finished. The display will read "P" if the test passes, and "F" if the test fails. For example, when the ROM test passes, the display will read: "TEST 1-ROM P".

INIT

Description

The INIT function is similar to the PRESET function in that it sets the Power Meter's parameters to a known state. INIT also, however, sets the front panel storage registers to the PRESET state. INIT also performs a checksum test on the sensor data tables. If a sensor data table fails the checksum test, check, the sensor data table will be cleared and the REF CF for that table will be set to 100.0%. If user attempts to select a Sensor Data table that has been cleared, the Power Meter will display "NO TBL DATA".

Calibration and zero information is lost in the INIT process. If INIT is enabled, ZERO and CAL should be performed before the next measurement.

Local Procedure

1. Press the SPECIAL (SHIFTed PRESET/LOCAL) key. The Power Meter will display a SPECIAL function with a blinking digit.
2. Use ▲ or ▼ to modify the blinking digit until the display reads "6 INIT".
3. Press the ENTER key. The display will read "INIT? N" with the "N" blinking.

4. To initialize the Power Meter, use ▲ or ▼ to change the "N" to "Y".
5. Press the ENTER key.
6. The Power Meter will display "INITIALIZING" for a few seconds. When the INIT function is finished, the Power Meter will display SELF TEST OK and then return to measurement mode.

Remote Procedure

There is no remote procedure for the INIT function.

STORE

Description

The Power Meter can store instrument configurations for recall at a later time. The following information can be stored in the Power Meter's internal registers:

REF CF value

Measurement units (dBm or watts)

REL value and status (on or off)

PWR REF status (on or off)

CAL FAC value (Calibration Factor)

SENSOR ID (sensor data table selection)

OFFSET value and status (on or off)

RANGE (Auto or Set)

FREQ value

RESOLN

DUTY CYCLE value and status (on or off)

Filter (number of readings averaged, auto or manual)

Limits value and status (on or off)

Registers 1 through 10 are available for storing instrument configurations.

Local Procedure

To store an instrument configuration:

1. Press STORE (SHIFTed [▼]). The Power Meter will display "STORE" and two digits, one of which will be blinking.
2. Modify the blinking digit (see below) until the desired storage register is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
3. Press ENTER.

Remote Procedure

The program code to STORE is ST. To store the current instrument configuration, send the command ST followed by the storage register number and the code EN (ENTER).

Example:

To store the instrument configuration in register 2:

```
ST2EN
```

HP-IB Program Codes

Parameter	Program Codes
STORE ENTER	ST EN

Comments

When an instrument configuration is STOREd in a storage register, the Power Meter automatically increments the STORE function to the next storage register. That is, if you STORE a configuration in register 4, the next time the STORE function is used the configuration will automatically be STOREd in register 5. This is to prevent accidentally erasing a previously stored configuration. The previous storage register can be accessed, however, through the [▲] and [▼] keys.

The REF CF value (reference calibration factor) for the power sensor can be STOREd and RECALLed but the internal calibration settings are not stored.

PRESET has no effect on the storage registers 1 through 10. Register 0 retains the configuration of the Power Meter immediately previous to being PRESET. If the Power Meter is accidently PRESET, the previous front panel configuration can be recovered using RECALL 0.

Storage register 0 is set to the PRESET state when RECALL FAIL (error 57) occurs.

Triggering

Description

Triggering is a feature that is only available via remote programming (HP-IB) of the Power Meter.

The Power Meter has two modes of triggered operation; standby mode and free run mode. Standby mode means the Power Meter is making measurements, but the display and HP-IB are not updated until a trigger command is received. Free run means that Meter takes measurements and updates the display and HP-IB continuously.

During local operation the Power Meter is always in free run mode. During remote operation the Power Meter can operate in either free run mode or standby mode and can be switched between modes at any time.

To obtain accurate measurements, ensure that the input power to the power sensor is settled before making a measurement.

Local Procedure

The Power Meter always triggers in free run mode when operating in local mode.

Remote Procedure

Two operating modes are available: free run mode and standby mode. Four triggering commands are available in remote mode: TR0, TR1, TR2, and TR3. TR3 puts the Power Meter into free run mode. TR0, TR1, and TR2 put the Power Meter into standby mode. These commands are detailed below.

Trigger Hold (TR0). Trigger hold is one of the three commands available when the Power Meter is in standby mode. Trigger hold is used to set up triggered measurements (initiated by program codes TR1, TR2, and the Trigger message). When in standby mode the Power Meter continues to measure the input signal, but the display and HP-IB bus are not updated. When the Power Meter receives the trigger immediate (TR1) or trigger with delay (TR2) command, a measurement is taken and the display and HP-IB bus data is updated. Upon completion of the measurement the Power Meter returns to standby mode.

When the Power Meter receives the free run (TR3) command, standby mode is exited. The Power Meter will then make continuous measurements and update the display until placed back in standby mode. Standby mode is also exited by returning the Power Meter to local operation using the

PRESET/LOCAL key. Upon leaving standby mode, the front panel display is updated as the new measurement cycle begins.

When in standby mode, internal Power Meter settings can be altered by the user via the HP-IB. The instrument will issue the Status Byte if serial polled.

Trigger Immediate (TR1). When the Power Meter receives the trigger immediate program code, it inputs one more data point into the digital filter, measures the reading from the filter, and then updates the display and HP-IB. (When the trigger immediate command is executed, the internal digital filter is not cleared.) The Power Meter then waits for the measurement results to be read by the controller. While waiting, the Power Meter can process most bus commands without losing the measurement results.

If the Power Meter receives a trigger immediate command and then receives the GET (Group Execute Trigger) command, the trigger immediate command will be aborted and a new measurement cycle will be executed.

Once the measurement results are read onto the bus, the Power Meter always reverts to standby mode. Measurement results obtained via trigger immediate are normally valid only when the Power Meter is in a steady, settled state.

Trigger with Delay (TR2). Triggering with delay is identical to trigger immediate except the Power Meter inserts a settling-time delay before taking the requested measurement. This settling time allows the internal digital filter to be updated with new values to produce valid, accurate measurement results. The trigger with delay command allows time for settling of the internal amplifiers and filters. It does not allow time for power sensor delay.

In cases of large power changes, the delay may not be sufficient for complete settling. Accurate readings can be assured by taking two successive measurements for comparison.

Once the measurement results are displayed and read onto the bus, the Power Meter reverts to standby mode.

Free Run (TR3). Free run mode is the default mode of operation and is identical to local operation. The measurement result data available to the HP-IB and display is continuously updated as rapidly as the Power Meter can make measurements. Entry into local mode via the PRESET/LOCAL key sets the Power Meter to the free run mode.

If the trigger immediate (TR1) or trigger with delay (TR2) command is received while the Power Meter is in free run mode, the trigger function will be executed immediately. Upon completion of the trigger function, the Power Meter will revert to standby mode.

When in free run mode, the Data Ready bit of the Status Byte is not updated.

HP-IB Program Codes

Parameter	Program Code
Trigger Hold	TR0
Trigger Immediate	TR1
Trigger with Delay	TR2
Free Run	TR3

Comments

When either of the trigger program codes TR1 or TR2 is received by the Power Meter, a measurement is immediately initiated. Once the measurement is completed, some bus commands can be processed without aborting the measurement. However, any HP-IB program code sent to the Power Meter before the triggered measurement results have been completed will abort the trigger. Thus, trigger codes should always appear at the end of a program string, and the triggered measurement results must be completed before any additional program codes that affect measurement are sent.

After receiving a trigger command, the response time to display a measurement depends on the range setting, the filter setting, the resolution, and the power sensor. See the Supplemental Characteristics in Section 1 for the response times.

ZERO

Description

ZERO is used to adjust the Power Meter's internal circuitry for a zero power indication when no power is applied to the sensor. Pressing the ZERO key automatically zeroes all five of the Power Meter's ranges.

Note

Ensure that no power is applied to the sensor while the Power Meter is zeroing. Any applied RF input power will cause an erroneous reading.

Local Procedure

1. Disconnect the power sensor from any power sources.
2. Press the ZERO key. The Power Meter will display "ZEROING *****".

Note

Zeroing will typically take 5-20 seconds. Zeroing time may vary depending on the power sensor used.

3. When the "ZEROING *****" display disappears, zeroing is finished.

Remote Procedure

To zero the power meter, send the command ZE.

HP-IB Program Codes

Parameter	Program Code
ZERO	ZE

Programming Example

The following program is written in BASIC 5.0 for the HP 9000 series 200 or 300 controllers. This program initiates the zero routine and displays whether the zeroing was successful or unsuccessful. Lines 3000 through 3230 comprise a subroutine that contains the zeroing routine. Lines 10 through 90 run the subroutine and print the result.

```
10    !  PROGRAM 'ZERO_437B'
20    !
30    CALL Zero_437b(713,Err)
40    IF Err=0 THEN
50    PRINT "ZERO SUCCESSFUL"
60    ELSE
70    PRINT "ZERO UNSUCCESSFUL"
80    END IF
90    END
3000  SUB Zero_437b(Hpib_address,Err)
3010  !
3020  ! 12/21/87:  Simple subroutine to ZERO the 437B power meter.
3030  ! If Err=0, then ZEROing was successful.
3040  ! If Err=1, then ZEROing was unsuccessful.
3050  !
3060  OUTPUT Hpib_address;"CS"          !Clear SPOLL register
3070  Time_zero=TIMEDATE                !Initialize time interval counter
3080  OUTPUT Hpib_address;"ZE"          !Send ZERO command
3090       I=1
3100       WHILE I                      !Cycle till Timeout, Routine finished
3110                                    !or measurement error occurs.
3120       Deltat=TIMEDATE-Time_zero    !Time variable
3130       Spval=SPOLL(Hpib_address)    !Check Status Byte
3140            IF Deltat>30 OR BIT(Spval,3) THEN
3150            Err=1                   !ZERO unsuccessful
3160            I=0
3170            END IF
3180            IF BIT(Spval,1) THEN
3190            Err=0                   !ZERO successful
3200            I=0
3210            END IF
3220       END WHILE
3230  SUBEND
3240  !
```

Comments

PRESET does not initiate the zeroing routine.

It is recommended that the Power Meter be zeroed before calibration.

The Power Meter's internal reference oscillator automatically turns off during zeroing. If the reference oscillator was on before zeroing was initiated it will be returned to the on state when zeroing is completed.

To determine whether or not the Power Meter needs to be zeroed, remove any power to the sensor and read the front panel display. If the display does not indicate 0.0 watts ±0.5%, the Power Meter needs to be zeroed. Any residual nonzero reading, if not corrected, will degrade the accuracy of subsequent measurements, resulting in an error. This error may be insignificant when measuring moderate to high power values, but it can be unacceptable when measuring low power values.

Error 57 (recall fail) occurs when the Power Meter is turned on and the internal RAM contents have been lost. This is generally due to battery failure but may also occur when the instrument is powered down while zeroing.

For remote (HP-IB) applications that require fast execution, the Cal/Zero Complete bit of the Status Byte can be used. When the zeroing routine is initiated through the ZE command, bit 1 (Cal/Zero Complete) of the Status Byte should be monitored until it is set true. When bit 1 is set true, the zeroing routine is finished and the program can continue.

If the status byte is to be used to monitor the end of the zeroing routine, the program string that initiated the zeroing routine should start with the program code CS. This will clear any previous setting of bit 1 (Cal/Zero Complete) to avoid an incorrect indication.

For best accuracy, HP 8484A Power Sensors should be connected to a device with the RF power off before zeroing.

Zeroing data cannot be STOREd and RECALLed, but it is remembered when the instrument is turned off.

PLEASE ZERO (Error 15) is displayed when the zero reference drifts below 0.0V.

4 PERFORMANCE TESTS

4-1. Introduction

The procedures in this section test the instrument's electrical performance using the specifications of Table 1-1 as the performance standards. All tests can be performed without access to the interior of the instrument. A simpler operational test is included in Section 3 under Basic Functional Checks.

Note

If the performance tests are to be considered valid, the following conditions must be met:

a. The Power Meter must have one-half hour warm-up for all specifications.

b. The line voltage for all instruments must be 100, 120, 220, or 240 Vac +5%, -10%; and the line frequency must be 48 to 66 Hz. The Power Meter has the additional capability of operating on line frequencies of 360 to 440 Hz, but the line voltage is limited to a nominal 100 to 120 Vac.

c. The ambient temperature must be 0° to 55° C.

4-2. Equipment Required

Equipment required for the performance tests is listed in Table 1-3, Recommended Test Equipment. Any equipment that satisfies the critical specifications given in the table may be substituted.

4-3. Performance Test Record

Results of the performance tests may be tabulated in Table 4-1, Performance Test Record. The Performance Test Record lists all of the performance test specifications and the acceptable limits for each specification. If performance test results are recorded during an incoming inspection of the instrument, they can be used for comparison during periodic maintenance or troubleshooting procedures. The test results may also prove useful in verifying proper adjustments after repairs are made.

4-4. Performance Tests

The performance tests given in this section are suitable for incoming inspection, troubleshooting, or preventive maintenance. During any performance test, all shields and connecting hardware must be in place. The tests are designed to verify published instrument specifications. Perform the tests in the order given and record the data in the Performance Test Record and/or in the data spaces provided at the end of each procedure.

4-5. Calibration Cycle

This instrument requires periodic verification of performance to ensure that it is operating within specified tolerances. The performance tests described in this section should be performed once each year. Under conditions of heavy usage or severe operating environments, the tests should be more frequent. Adjustments that may be required are described in Section 5, Adjustments.

4-6. Test Procedures

It is assumed that the person performing the following tests understands how to operate the specified test equipment. Equipment settings, other than those for the Power Meter, are stated in general terms. It is also assumed that the technician will select the proper power sensor, cables, adapters, and probes required for test setups illustrated in this section.

4-7. Zero Carryover Test

Specification

Electrical Characteristics	Performance Limits	Conditions
Accuracy: Zero set (Digital settability of zero)	±0.5% full scale	Most sensitive range. Decrease percentage by factor of 10 for each higher range ±1 count.

Description

After the Power Meter is initially zeroed, the change in the digital readout is monitored as the Power Meter is stepped through its ranges. This test also checks drift and noise since drift, noise, and zero carryover readings cannot be separated.

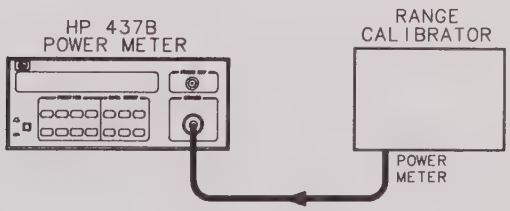


Figure 4-1. Zero Carryover Test Setup

Equipment

Range Calibrator.....HP 11683A
Power Sensor Cable.....HP 11730A

Procedure

1. Press the Power Meter's LINE switch to ON.

2. Press PRESET/LOCAL.

3. Press dBm/W for a meter reading in watts.

4. Set the range calibrator as follows:

RANGE 3μW
FUNCTION .....STANDBY
LINE.....ON

5. Press the Power Meter's ZERO key. Wait approximately 15 seconds for the "ZEROING****" display to disappear. Verify that the display reads 0.00 ±0.06 μW.

6. Press SET RANGE, then ENTER.

7. Press ▲ or ▼ until the display reads "RNG 1 -20dB". Press ENTER.

8. Verify that the Power Meter's reading is within the limits shown in the table below. Record the reading.

9. Repeat steps 6 through 8 by entering RNG 2, RNG 3, RNG 4, and RNG 5.

Power Meter Range	Min	Actual Results	Max
1	-0.05 μW	_____	0.05 μW
2	-0.1 μW	_____	0.1 μW
3	-0.001 mW	_____	0.001 mW
4	-0.01 mW	_____	0.01 mW
5	-0.1 mW	_____	0.1 mW

4-8. Instrument Accuracy Test

Specification

Electrical Characteristics	Performance Limits	Conditions
Accuracy: Instrumentation, includes sensor linearity.[1]	±0.5% or ±0.02 dB	Within same calibration range

[1] When operating in Ranges 4 or 5, add the corresponding sensor power linearity percentage.

Description

The Power Meter is initially calibrated on the 1 mW range. The readout is then monitored as the range calibrator is switched to provide reference inputs corresponding to each of the Power Meter operating ranges.

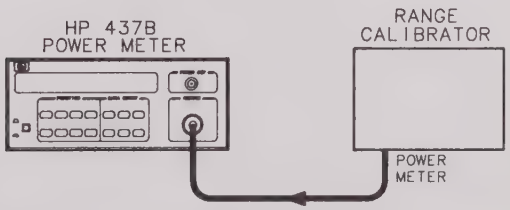


Figure 4-2. Instrument Accuracy Test Setup

Equipment

Range Calibrator	HP 11683A
Power Sensor Cable	HP 11730A

Procedure

1. Connect the equipment as shown in Figure 4-2.

2. Press the Power Meter's LINE switch to ON.

3. Press PRESET/LOCAL

4. Press dBm/W for a meter reading in watts.

5. Set the range calibrator as follows:

FUNCTION	STANDBY
POLARITY	NORMAL
RANGE	3 μW
LINE	ON

Note

When switching the range calibrator to STANDBY, allow enough time for the range calibrator to settle to its zero value before attempting to zero the Power Meter. This settling would appear on the Power Meter display as downward drift. When the drift has reached minimum, (typically less than 60 seconds), the range calibrator is settled.

6. Press the Power Meter's ZERO key. Wait approximately 15 seconds for the "ZEROING:*****" display to disappear. Verify that the display reads 0.00 ±0.05 μW.

7. Set the range calibrator's FUNCTION switch to CALIBRATE.

8. Set the range calibrator's RANGE switch to 1 mW.

9. Press the Power Meter's CAL key (SHIFTed ZERO).

10. Press [▲] or [▼] until the display reads "REF CF 100.0%"

11. Press ENTER. (The display will read "CAL***" for a few seconds.)

12. Verify that the Power Meter display reads 1.000 ±0.001 mW.

13. Set the range calibrator's RANGE switch to the positions shown in the following table. For each setting, verify that the Power Meter's reading is within the limits shown.

Range Calibrator Setting	Min	Actual Results	Max
3 µW	3.10 µW	_____	3.23 µW
10 µW	9.90 µW	_____	10.10 µW
30 µW	31.4 µW	_____	31.8 µW
100 µW	99.5 µW	_____	100.5 µW
300 µW	.314 mW	_____	.318 mW
1 mW	0.995 mW	_____	1.005 mW
3 mW	3.14 mW	_____	3.18 mW
10 mW	9.95 mW	_____	10.05 mW
30 mW	31.4 mW	_____	31.8 mW
100 mW	99.5 mW	_____	100.5 mW

Note

It is not necessary to check instrument accuracy in dBm. The Power Meter uses the same internal circuitry to measure power and mathematically converts watts to dBm.

4-9. Power Reference Level Test

Specification

Electrical Characteristics	Performance Limits	Conditions
Power reference	1.0 mW	Internal 50 MHz oscillator factory set to ±0.7% traceable to National Bureau of Standards.
Power reference Accuracy	±1.2% ±0.9%	Worst case. RSS for one year.

Description

The power reference oscillator output is factory adjusted to 1 mW ±0.7%. To achieve this accuracy, Hewlett-Packard employs a special measurement system accurate to 0.5% (traceable to the National Bureau of Standards) and allows for a transfer error of ±0.2% in making the adjustment. If an equivalent measurement system is employed for verification, the power reference oscillator output can be verified to 1 mW ±1.9% (±1.2% accuracy plus ±0.5% verification system error plus ±0.2% transfer error=1.9% maximum error).

The power reference oscillator can be set to ±0.7% using the same equipment and following the adjustment procedure. To ensure maximum accuracy in verifying the power reference oscillator output, the following procedure provides step by step instructions for using specified Hewlett-Packard test instruments of known capability. If equivalent test instruments are used, signal acquisition criteria may vary and reference should be made to the manufacturer's guidelines for operating the instruments.

Note

The Power Meter may be returned to the nearest Hewlett-Packard office to have the power reference oscillator checked and/or adjusted. Refer to Section 2, Packaging.

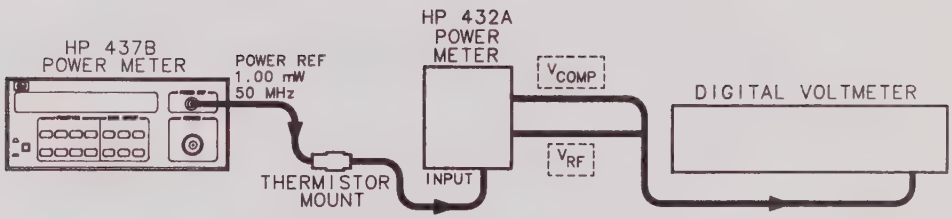


Figure 4-3. Power Reference Level Test Setup

Equipment

Test Power Meter	HP 432A
Thermistor Mount	HP 478A-H75
Digital Voltmeter (DVM)	HP 3456A

Procedure

1. Set the DVM to measure resistance. Connect the DVM between the Vrf connector on the rear panel of the test power meter, and pin 1 on the thermistor mount end of the test power meter interconnect cable.

2. Round off the DVM indication to two decimal places and record this value as the internal bridge resistance (R) of the test power meter (approximately 200Ω).

R_____

3. Connect the test power meter to the Power Meter as shown in Figure 4-3.

4. Press the Power Meter's LINE switch to ON.

5. Press PRESET/LOCAL, then ENTER.

Note Wait thirty minutes for the test power meter thermistor mount to stabilize before proceeding to the next step.

6. Set the test power meter RANGE switch to Coarse Zero. Adjust the front panel Course Zero control to obtain a zero meter indication.

7. Fine zero the test power meter on the most sensitive range, then set the RANGE switch to 1 mW.

Note Ensure that the DVM input leads are isolated from chassis ground when performing the next step.

8. Set the DVM to measure microvolts. Connect the positive and negative input leads, respectively, to the Vcomp and Vrf connectors on the rear panel of the test power meter.

9. Observe the reading on the DVM. If less than 400 microvolts, proceed to the next step. If 400 microvolts or greater, press and hold the test power meter Fine Zero switch and adjust the Coarse Zero control so that the DVM indicates 200 microvolts or less. Release the Fine Zero switch and proceed to the next step.

10. Round the DVM reading to the nearest microvolt. Record this reading as V0.

V0 _____

11. On the Power Meter under test, press PWR REF (SHIFTed [▶]) to turn the power reference oscillator on.

12. Observe the reading on the DVM. Record the reading as V1.

V1 _____

13. Disconnect the DVM negative input lead from the Vrf connector on the test power meter. Reconnect it to the test power meter chassis ground.

14. Observe the DVM reading. Record the reading as Vcomp.

Vcomp _____

15. Calculate the power reference oscillator output level (Prf) from the following formula:

$$Prf = \frac{2V_{comp}(V_1 - V_0) + V_0^2 - V_1^2}{4R \text{ (Calibration Factor)}}$$

Where:
Prf=power reference oscillator output level
Vcomp=previously recorded value
V1=previously recorded value
V0=previously recorded value
R=previously recorded value

Calibration Factor=value for thermistor mount at 50 MHz (traceable to the National Bureau of Standards).

16. Verify that Prf is within the limits shown in the following table. Record the reading.

Min	Actual	Max
0.988 mW	_____	1.012 mW

Hewlett-Packard Company
Model HP 437B
Power Meter

Tested by _____

Serial Number _____ Date _____

Table 4-1. Performance Test Record

Para. No.	Test	Min. Result	Actual Result	Max. Result
4-7.	**ZERO CARRYOVER** Power Meter Range			
	1	-0.05 μW	_____	0.05 μW
	2	-0.1 μW	_____	0.1 μW
	3	-0.001mW	_____	0.001 mW
	4	-0.01 mW	_____	0.01 mW
	5	-0.1 mW	_____	0.1 mW
4-8.	**INSTRUMENT ACCURACY** Accuracy			
	3 μW	3.10 μW	_____	3.23 μW
	10 μW	9.90 μW	_____	10.10 μW
	30 μW	31.4 μW	_____	31.8 μW
	100 μW	99.5 μW	_____	100.5 μW
	300 μW	.314 mW	_____	.318 mW
	1 mW	0.995 mW	_____	1.005 mW
	3 mW	3.14 mW	_____	3.18 mW
	10 mW	9.95 mW	_____	10.05 mW
	30 mW	31.4 mW	_____	31.8 mW
	100 mW	99.5 mW	_____	100.5 mW
4-9.	**POWER REFERENCE** Prf	0.988 mW	_____	1.012 mW

A ERROR MESSAGES

Description

The Power Meter generates error messages to indicate operating problems, incorrect HP-IB entries, and service-related problems.

Error messages are grouped as follows:

Errors 01 through 49. These are measurement errors, which indicate that not all conditions have been met to assure a calibrated measurement. Measurement errors can usually be cleared by readjusting the front panel controls or changing the equipment setup.

Errors 50 through 59 and 80 through 99. These are entry errors, which indicate that an invalid HP-IB entry has been made. These errors require that a new HP-IB entry be made.

Errors 60 through 79. These are service errors, which provide service-related information. Service errors are discussed in Section 8 of this manual.

Error Displays

Errors 1 through 49, 57, and 80 are indicated by a brief message that appears in the Power Meter's display. See Table A-1 for an explanation of these errors.

HP-IB Output Format

As long as the front panel display indicates a measurement error, the instrument sends 9.00XXE+40 as the measured data when addressed to talk. XX in the Data message is the error code for that particular error.

If an error condition generates SRQ, the status byte and status message latch the error until the status message (program code SM) has been read by the HP-IB controller. Once the status message has been read, the status byte and status message are cleared if the error condition no longer exists. If multiple errors occur, the status message indicates the most recent error.

If an error condition does not generate SRQ (for example, the Service Request Mask has been set such that measurement or entry errors do not set the status byte's RQS bit true), the status byte and status message latch all entry errors. Measurement errors, however, are latched only if 9.00XXE+40 has been sent over the HP-IB. The status byte and status message are cleared by removing the cause of the error and then reading the status message over the HP-IB.

Error Messages

Table A-1, Error Messages, describes all measurement and entry errors. The error code, front panel error display, message, and action typically required to remove the error-causing condition are given.

Table A-1. Error Messages

Error Code	Error Display	Message	Action Required
01	CANNOT ZERO	Power Meter cannot zero the sensor	Ensure that no RF power is being applied to the sensor during zeroing
05	CAL ERROR	Power Meter cannot calibrate sensor	Make sure power sensor is connected to a 1 mW 50 MHz source
11	INPUT OVL	Input overload on sensor	Reduce input power to sensor
15	PLEASE ZERO	Sensor's zero reference has drifted negative	Zero sensor. If error persists, check input power
17	UP RANGE	Input power on sensor is too high for current range	Select a higher range, reduce input power to sensor, or use AUTO RNG
21	OVER LIMIT	Power reading over high limit	Check input power at sensor, adjust limit, or disable limit checking function
23	UNDER LIMIT	Power reading under low limit	Check input power at sensor, adjust limit, or disable limit checking function
31	NO SENSOR	No sensor connected to the input	Connect a sensor to the input

Table A-1. Error Messages (Cont.)

Error Code	Error Display	Message	Action Required
33	2 SENSOR ERR	Both front and rear sensor inputs have sensors connected (Option 002 or Option 003 only)	Remove one of the 2 sensors connected to sensor input
		ENTRY ERRORS	
50		Entered cal factor is out of range	Re-enter value between 1.0 and 150.0
51		Entered offset is out of range	Re-enter value between -99.99 and +99.99
52		Entered range number is out of range	Re-enter range number between 0 and 5
54		Entered recall register number is out of range	Re-enter register number between 0 and 10
55		Entered storage register number is out of range	Re-enter register number between 1 and 10
56		Entered reference cal factor is out of range	Re-enter CAL value between 50.0 and 120.0
57	RECALL FAIL	RAM ID check failure	Refer to footnote below
		HARDWARE ERRORS	
61-69		Service-related errors	Refer to Service-Related Errors in Section 8, Service

Error 57 occurs when the instrument is turned on and the internal RAM contents have been lost. This is generally due to battery failure, but may also occur when the Power Meter executes the self test function or is powered down during the end of a zero or calibration sequence. The error indication is cleared after two seconds or by selecting another function (the selected function will be executed). Once the error indication is cleared, the Power Meter is configured in the PRESET state.

Table A-1. Error Messages (Cont.)

Error Code	Error Display	Message	Action Required
80	NO TBL DATA	ENTRY ERRORS No calibration data loaded in the selected sensor data table	Enter calibration data into the table for the selected sensor via the SPECIAL key, select a different table, or enter a calibration factor via the CAL FAC key
81		Entered duty cycle value out of range	Re-enter duty cycle value between 0.001 and 99.999%
82		Entered frequency value out of range	Re-enter frequency value between 100 kHz and 999.9999 GHz
85		Entered resolution is out of range	Re-enter resolution number between 1 and 3
86		Sensor table reference calibration factor is out of range	Re-enter reference cal factor between 50.0 and 120%
87		Sensor selection out of range	Re-enter sensor number between 0 and 9
88		Sensor ID characters invalid	Re-enter sensor ID number using only alphanumeric characters (1-9 and A-Z)
90		HP-IB data without valid prefix	Check, then re-enter valid prefix with data
91		Invalid HP-IB code	Check, then re-enter correct HP-IB code
92		Event status enable mask out of range	Re-enter status enable mask value
93		SRQ mask value out of range	Re-enter mask value between 0 and 255

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February, 1986

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COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER _____

over

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MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER _____

over

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COMPANY

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MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER _____

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MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER _____

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MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER _____

over

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COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER _____

over

5955-8108

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

_____

_____

_____

_____

_____

_____

_____

If unit is part of system list model number(s) of other interconnected instruments. _____

_____

9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

_____

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_____

_____

_____

_____

_____

If unit is part of system list model number(s) of other interconnected instruments. _____

_____

9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

_____

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If unit is part of system list model number(s) of other interconnected instruments. _____

_____

9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

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_____

If unit is part of system list model number(s) of other interconnected instruments. _____

_____

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Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

_____

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_____

If unit is part of system list model number(s) of other interconnected instruments. _____

_____

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Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

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_____

If unit is part of system list model number(s) of other interconnected instruments. _____

_____

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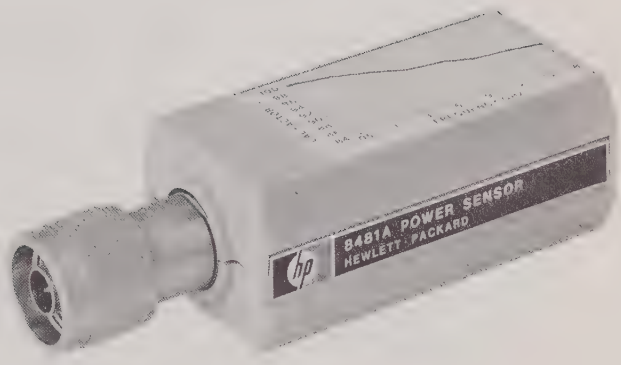
#022

OPERATING AND SERVICE MANUAL

8481A
8482A
8483A
POWER SENSOR



HEWLETT PACKARD

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Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

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OPERATING AND SERVICE MANUAL

8481A
8482A
8483A
POWER SENSOR

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed: 8481A: 1926A
8482A: 1925A
8483A: 1925A

With the changes in the Appendix this manual also applies to instruments with serial numbers prefixed:
8481A: 1550A
8482A: 1551A
8483A: 1602A

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL on page 2.

HEWLETT PACKARD

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1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

MANUAL PART NUMBER 08481-90063
Microfiche Part Number 08481-90064

Printed: OCTOBER 1980

1. GENERAL INFORMATION

2. This Operating and Service Manual contains information about initial inspection, performance tests, adjustments, operation, troubleshooting and repair of the Model 8481A, 8482A, and 8483A Power Sensors.

3. On the title page of this manual is a "Microfiche" part number. This number can be used to order a 4 x 6-inch microfilm transparency of the manual.

4. Instruments Covered by Manual

5. This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form a sequential suffix which is unique to each instrument. The contents of this manual apply directly to instruments having the serial number prefix listed under SERIAL NUMBERS on the title page.

6. An instrument manufactured after the printing of this manual may have a serial prefix that is not listed on the title page. This unlisted serial prefix indicates that the manual for this instrument is supplied with a yellow Manual Changes supplement that documents the differences.

7. In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement is keyed to the manual print date and part number, both of which appear on the title page. Complimentary copies of the supplement are available on request from your nearest Hewlett-Packard office.

8. For information concerning a serial number prefix not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

9. Description

10. The Power Sensors are used for measuring the average power supplied by an RF source. In use, the Power Sensor is connected to the RF source and to a compatible power meter. (Suitable meters are the HP 435 series or 436A Power Meter.) The 8481A and 8482A Power Sensors place a 50-ohm load on the RF source (8483A has a 75-ohm load). The power meter indicates the power dissipated in this load in μW (or mW) and dBm. The HP 436A Power Meter can also provide readings, in dB, relative to a previous RF input to the Power Sensor.

11. The Power Sensors measure power levels from −30 dBm to +20 dBm (1 μW to 100 mW), at frequencies from 10 MHz to 18 GHz (8481A), or 100 kHz to 4.2 GHz (8482A), or 100 kHz to 2 GHz (8483A).

12. The physical configuration of all sensors is the same. However, because of the different frequency ranges covered, there are some changes in part numbers and component values.

13. CAL FACTOR data is provided on a label attached to the Power Sensor's cover. Maximum uncertainties of the CAL FACTOR data are listed in Table 1.

14. Specifications for the Power Sensor are provided in Table 2.

15. Option 001 (8481 only)

16. A precision 7 mm RF connector (APC-7) is substituted for the type-N connector.

17. Accessories Supplied

18. The Model 8483A is supplied with an adapter (HP 1250-0597, shown in Figure 1) for joining the Power Sensor's 75-ohm Type N connector to the 50-ohm power reference connector on the power meter. This accessory is a mechanical adapter only, not an impedance transformer. Therefore, an impedance mismatch exists and the meter should be calibrated to 96% of the power reference level at 50 ohms (e.g., 0.96 mW for the HP Model 435 series).

CAUTION

Remove mechanical adapter from the Power Sensor before connecting the sensor to a 75-ohm source.

19. Recommended Test Equipment

20. Table 3 lists the test equipment recommended to check, adjust, and troubleshoot the Power Sensor. If substitute equipment is used, it must meet or exceed the critical specifications.

21. INSTALLATION

22. Initial Inspection

23. Inspect the shipping container. If the container or packing material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. If there is mechanical damage or if the instrument does not pass the performance tests, notify the nearest Hewlett-Packard office. Keep the damaged shipping materials (if any) for inspection by the carrier and a Hewlett-Packard representative.

Table 1. Uncertainty of Calibration Factor Data[3]

8481A					
Frequency (MHz)	Sum of Uncertainties ±(%)[1]	Probable Uncertainties ±(%)[2]	Frequency (GHz)	Sum of Uncertainties ±(%)[1]	Probable Uncertainties ±(%)[2]
10.0	2.5	1.3	1.0	2.7	1.4
30.0	2.6	1.4	2.0	2.7	1.4
100.0	3.1	1.6	4.0	2.8	1.5
300.0	3.1	1.6	6.0	2.8	1.5
			8.0	3.2	1.7
			10.0	3.6	1.9
			12.4	4.4	2.3
			14.0	4.8	2.6
			16.0	5.2	2.9
			18.0	5.8	3.2

8482A			8483A		
Frequency (MHz)	Sum of Uncertainties ±(%)[1]	Probable Uncertainties ±(%)[2]	Frequency (MHz)	Sum of Uncertainties ±(%)[1]	Probable Uncertainties ±(%(2
0.1	2.3	1.3	0.1	2.6	1.5
0.3	2.2	1.2	0.3	2.5	1.4
1.0	2.2	1.2	1.0	2.5	1.4
3.0	2.2	1.2	3.0	2.5	1.4
10.0	2.5	1.3	10.0	3.0	1.6
30.0	2.6	1.4	30.0	3.1	1.6
100.0	3.1	1.6	100.0	3.9	2.0
300.0	3.1	1.6	300.0	3.9	2.0
1000.0	2.7	1.4	1000.0	3.7	2.0
2000.0	2.7	1.4	2000.0	3.7	2.0
4000.0	2.8	1.5			

[1] Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NBS.

[2] Square root of the sum of the individual uncertainties squared (RSS).

[3] Uncertainties are for sensors with type N connectors. Values will be slightly less for sensors with APC-7 connectors.

Table 2. Specifications

Model 8481A
Power Range: −30 dBm to +20 dBm (1 μW − 100 mW)
Frequency Range: 10 MHz − 18 GHz
Nominal Impedance: 50Ω
Maximum SWR (Reflection Coefficient): 10 MHz to 30 MHz < 1.4 (0.166)
30 MHz to 50 MHz < 1.18 (0.083)
50 MHz to 2 GHz < 1.10 (0.048)
2 GHz to 12.4 GHz < 1.18 (0.083)
12.4 GHz to 18 GHz < 1.28 (0.123)
Maximum Power: 300 mW Average − **Maximum Peak Power:** 15W Peak − **Maximum Energy/Pulse:** 30W·μs
RF Connector: Type N Male

Model 8482A
Power Range: −30 dBm to +20 dBm (1 μW − 100 mW)
Frequency Range: 100 kHz − 4.2 GHz
Nominal Impedance: 50Ω
Maximum SWR (Reflection Coefficient): 100 kHz to 300 kHz < 1.60 (0.231)
300 kHz to 1 MHz < 1.20 (0.091)
1 MHz to 2 GHz < 1.10 (0.048)
2 GHz to 4.2 GHz < 1.30 (0.130)
Maximum Power: 300 mW Average − **Maximum Peak Power:** 15W Peak − **Maximum Energy/Pulse:** 30W·μs
RF Connector: Type N Male

Model 8483A
Power Range: −30 dBm to +20 dBm (1 μW − 100 mW)
Frequency Range: 100 kHz − 2 GHz
Nominal Impedance: 75Ω
Maximum SWR (Reflection Coefficient): 100 kHz to 600 kHz < 1.80 (0.286)
600 kHz to 2 GHz < 1.18 (0.083)
Maximum Power: 300 mW Average − **Maximum Peak Power:** 10W Peak − **Maximum Energy/Pulse:** 30W·μs
RF Connector: Type N Male (75Ω)

Dimensions, Including RF Connector: 30 mm wide, 38 mm high, 105 mm long (1-3/16 in. x 1-1/2 in. x 5-7/8 in.).

Weight: Net, 0.2 kg (8 oz.).

Figure 1. Mechanical Adapter (8483A Only)

24. Storage and Shipment

25. Environment. The instrument should be stored in a clean, dry environment. The following limitations apply to both storage and shipment:

a. Temperature, −40 to +75°C
b. Relative humidity, less than 95%
c. Altitude, less than 7,600 metres (25,000 feet).

26. Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and serial number.

Table 3. Recommended Test Equipment

Instrument Type	Critical Specifications	Suggested Model	Use*
Digital Voltmeter	Range: 100 mVdc to 100 Vdc Input Impedance: 10 megohms Resolution: 4-digit Accuracy: ±0.05% ±1 digit	HP 3465A/B	T
Oscilloscope	Bandwidth: dc to 50 MHz Sensitivity: Vertical, 0.2V/div Horizontal, 1 ms/dv	HP 180C/1801A/1821A or HP 1740A	A, T
10:1 Divider Probe	10 Megohms 10 pF	HP 10004D	A
Ohmmeter	Range: 1 ohm to 100,000 ohms Accuracy: ±5%	HP 3465A/B	T
DC Power Supply	Range: 5 to 15 Vdc	HP 6214A	T

*A = Adjustment, T = Troubleshooting.

27. INTERCONNECTIONS

28. Refer to the power meter operating and service manual for interconnecting instructions.

29. OPERATION

30. Environment

31. The operating environment for the Power Sensor should be as follows:

a. Temperature, 0° to 55°C
b. Relative humidity, less than 95%
c. Altitude, less than 4,572 metres (15,000 feet).

32. Operating Precautions

33. Before the Power Sensor is connected, the following precautions must be observed.

WARNING

BEFORE CONNECTING THE POWER SENSOR TO ANOTHER INSTRUMENT, ensure that the instrument and power meter are connected to the protective (earth) ground.

Exceeding the energy and power levels shown in paragraph 34 may result in damage to the power meter system.

Do not apply torque to the Power Sensor's body while connecting or disconnecting the Type N RF connector.

NOTE

When using the Power Sensor with the 435 series Power Meter make sure the correct scale is mounted on the Power Meter RANGE switch. Refer to Section II of the 435 series Power Meter Operating and Service Manual.

34. The absolute maximum RF signal level that may be coupled to the Power Sensor is:

a. Maximum Average Power: 300 mW
b. Maximum Peak Power: 15W (10W 8483A only)
c. Maximum Energy Per Pulse: 30W · μs.

35. Operating Procedures

36. Calibration is performed as follows:

a. For the HP 435 series Power Meter, set the RANGE switch to 1 mW, and adjust the CAL ADJ control to bring the needle on the meter to the CAL position.

b. For the HP 436A Power Meter, adjust the CAL ADJ control to obtain a reading of 1 mW on the digital display.

37. Instructions for use of the Power Sensor are provided in the power meter manual. Note, however, the different calibration procedure described in paragraph 36 above. During operation, the precautions in paragraph 33 must be observed.

38. SWR (REFLECTION COEFFICIENT PERFORMANCE TEST

39. The maximum SWR and reflection coefficient for each Power Sensor are listed in Table 4. For making these measurements, use equipment which has measurement uncertainties not exceeding those shown in the table.

40. FET BALANCE ADJUSTMENT

41. The sampling gate balance is affected by the relative positions of the wires in the Power Sensor which connect to pins G and H of connector J1. One wire is black and white, and the other is brown and white. Once positioned, care must be used not to displace these wires.

42. To correctly position these wires, after replacement of A2U1, connect an oscilloscope as follows to display switching transients:

a. Test point A4TP4 in the HP 435 series Power Meter, or

b. Test point A2TPAC (e) in the HP 436A Power Meter.

43. Adjust the black-and-white and brown-and-white wires until the switching transient amplitude is less than 0.8 Vp-p.

44. REPLACEABLE PARTS

45. Table 5 is a list of replaceable parts. Figure 2 illustrates the major parts. To order a part listed in the Replaceable Parts table, quote the Hewlett-Packard Part Number with Check Digit (CD), indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

NOTE

Within the USA, it is better to order directly from the HP Parts Center in Mt. View, California. Ask your nearest HP office for information and forms for the "Direct Mail Order System".

Table 4. SWR and Reflection Coefficient

Frequency	System SWR Uncertainty	Actual Measurement	Maximum SWR (Reflection Coefficient)
	8481A		
10 to 30 MHz	±0.030	_____	< 1.40 (0.166)
30 to 50 MHz	±0.020	_____	< 1.18 (0.083)
50 MHz to 2 GHz	±0.020	_____	< 1.10 (0.048)
2 to 12.4 GHz	±0.020	_____	< 1.18 (0.083)
12.4 to 18 GHz	±0.025	_____	< 1.28 (0.123)
	8482A		
100 kHz to 300 kHz	±0.08	_____	< 1.60 (0.231)
300 kHz to 1 MHz	±0.04	_____	< 1.20 (0.091)
1 MHz to 2 GHz	±0.02	_____	< 1.10 (0.048)
2 GHz to 4.2 GHz	±0.02	_____	< 1.30 (0.130)
	8483A		
100 kHz to 600 kHz	±0.08	_____	< 1.80 (0.286)
600 kHz to 2 GHz	±0.02	_____	< 1.18 (0.083)

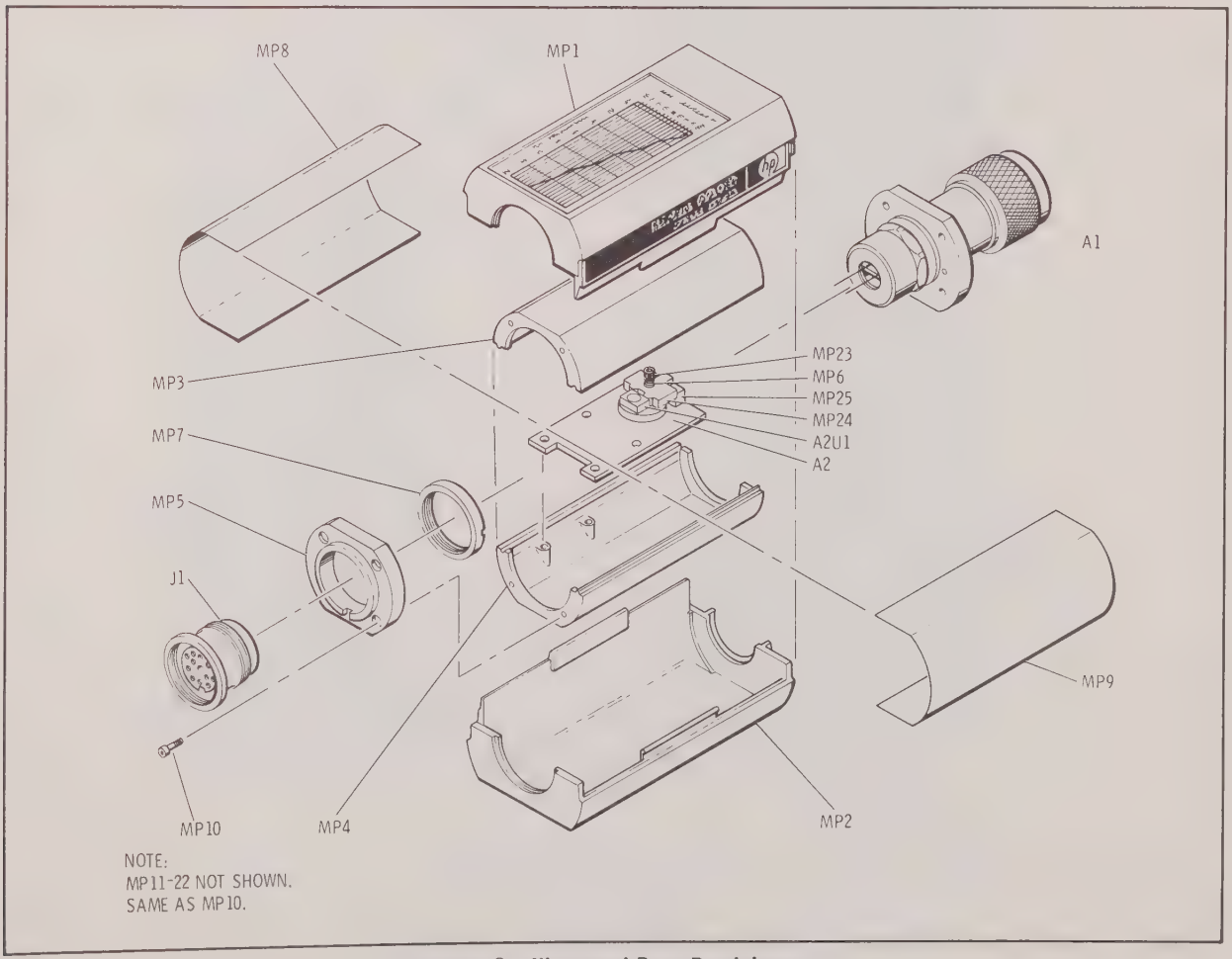


Figure 2. Illustrated Parts Breakdown

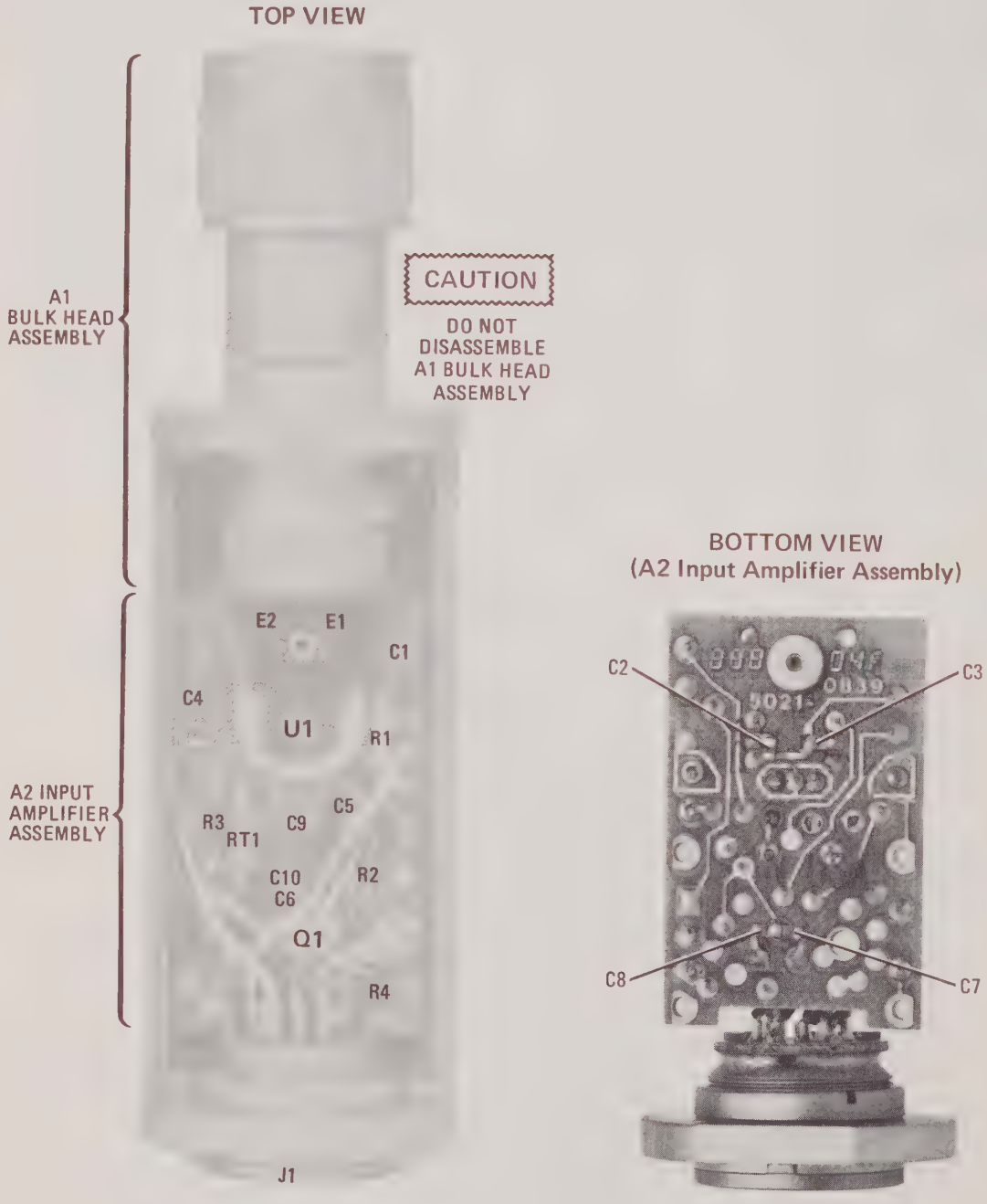


Figure 3. Component and Assembly Locations

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	08481-60004	3	1	BULKHEAD, TYPE N (FOR 8481A ONLY)	28480	08481-60004
A1	08481-60005	4	1	BILKHEAD, APC-7(FOR 8481A OPT 001 ONLY)	28480	08481-60005
A1	08482-60003	3	1	BULKHEAD, TYPE N (FOR 8482A ONLY)	28480	08482-60003
A1	08483-60003	4	1	BULKHEAD, TYPE N (FOR 8483A ONLY)	28480	08483-60003
A2	08481-60025	8	1	POWER SENSOR BOARD ASSEMBLY (FOR 8481A)	28480	08481-60025
A2	08482-60013	5	1	POWER SENSOR BOARD ASSEMBLY (FOR 8482A)	28480	08482-60013
A2	08483-60007	8	1	POWER SENSOR BOARD ASSEMBLY (FOR 8483A)	28480	08483-60007
A2C1	0180-2515	8	2	CAPACITOR-FXD 47UF+-20% 6VDC TA (FOR 8481A ONLY)	28480	0180-2515
A2C1	0180-0555	2	1	CAPACITOR-FXD 39UF+-20% 10VDC TA (FOR 8482A ONLY)	28480	0180-0555
A2C1	0180-0556	3	1	CAPACITOR-FXD 27UF+-20% 15VDC TA (FOR 8483A ONLY)	28480	0180-0556
A2C2	0160-4306	7	4	CAPACITOR-FXD 100PF +-10% 100VDC CER	28480	0160-4306
A2C3	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	28480	0160-4306
A2C4	0180-0594	9	1	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	14433	TAG-10-3.3/16-20
A2C5	0160-3094	8	1	CAPACITOR-FXD .1UF +-10% 100VDC CER	28480	0160-3094
A2C6	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C7	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	28480	0160-4306
A2C8	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	28480	0160-4306
A2C9	0180-2515	8		CAPACITOR-FXD 47UF+-20% 6VDC TA	28480	0180-2515
A2C10	0180-2545	4	1	CAPACITOR-FXD 100UF+-20% 4VDC TA	28480	0180-2545
A2Q1	1854-0610	0	1	TRANSISTOR NPN SI TO-46 FT=800MHZ	28480	1854-0610
A2R1	0698-3260	9	1	RESISTOR 464K 1% .125W F TC=0+-100 (FOR 8481A ONLY)	28480	0698-3260
A2R1	0757-0483	8	1	RESISTOR 562K 1% .125W F TC=0+-100 (FOR 8482A ONLY)	28480	0757-0483
A2R1	0698-8352	0	1	RESISTOR 787K 1% .125W F TC=0+-100 (FOR 8483A ONLY)	28480	0698-8352
A2R2	0698-7248	1	1	RESISTOR 3.16K 1% .05W F TC=0+-100	24546	C3-1/8-TO-3161-G
A2R3	0698-7224	3	1	RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-TO-316R-G
A2R4	0698-7236	7	1	RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1001-G
A2RT1	0811-3210	1	1	RESISTOR 31.6 5% .05W PWW TC=+5040+-252	14140	1409-1/20-31R6-J
A2U1	1813-0060	8	1	TO-8	28480	1813-0060
				A2 MISCELLANEOUS PARTS		
	0590-1040	1	1	THREADED INSERT-NUT 0-80 .06-LG SST	28480	0590-1040
	5040-6938	6	1	SPACER	28480	5040-6938
				CHASSIS PARTS		
J1	08481-60024	7	1	CONNECTOR ASSEMBLY, 12-PIN	28480	08481-60024
MP1	08481-40002	9	2	SHELL, PLASTIC	28480	08481-40002
MP2	08481-40002	9		SHELL, PLASTIC	28480	08481-40002
MP3	08481-20011	8	2	CHASSIS	28480	08481-20011
MP4	08481-20011	8		CHASSIS	28480	08481-20011
MP5	08481-20008	3	1	END BELL	28480	08481-20008
MP6	1460-1224	9	1	SPRING, CPRSN .1-OD,.15-LG MUW	28480	1460-1224
MP7	1251-3363	8	1	NUT, CONNECTOR MOUNTING	28480	1251-3363
MP8	08481-00002	5	2	SHIELD	28480	08481-00002
MP9	08481-00002	5		SHIELD	28480	08481-00002
MP10	3030-0422	8	13	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP11	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP12	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP13	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP14	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP15	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP16	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP17	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP18	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP19	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP20	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP21	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP22	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP23	3030-0436	4	1	SCREW-SKT HD CAP 0-80 .5-IN-LG SST-300	00000	ORDER BY DESCRIPTION
MP24	5040-6939	7	1	CLAMP	28480	5040-6939
MP25	5040-6940	0	1	BLOCK	28480	5040-6940
MP26	7120-3117	9	1	LABEL, ID-RIGHT	28480	7120-3117
MP26	7120-3118	0	1	LABEL,ID-LEFT (FOR 8481A ONLY)	28480	7120-3118
MP27	7120-4179	5	1	LABEL, ID (FOR 8482A ONLY)	28480	7120-4179
MP28	1250-0597	2	1	ADAPTER, COAX M-N F-N	28480	1250-0597
MP28	1250-4204	6	1		28480	1250-4204

See introduction to this section for ordering information
*Indicates factory selected value

Table 6. Code List of Manufacturers

Mfr. No.	Manufacturer Name	Address	Zip Code
00000	ANY SATISFACTORY SUPPLIER		
14140	EDISON ELEK DIV McGRAW-EDISON	MANCHESTER NH	03130
14433	ITT SEMICONDUCTORS DIV OF ITT CORP	PALM BEACH FL	33401
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304

46. SERVICE

47. Test equipment which meets or exceeds the critical specifications in Table 3 may be used in place of the recommended instruments for troubleshooting the Power Sensor.

48. Figure 3 shows the locations of the assemblies and components. Figure 4 is the schematic diagram.

49. Principles of Operation

50. Bulkhead assembly A1 presents either a 50-ohm load (8481A and 8482A) or a 75-ohm load (8483A) to the RF signal applied to the power sensor. The RF signal absorbed by the thermocouples generates a dc voltage that is proportional to the RF input power.

51. Components A2E1 and A2E2 are ferrite beads situated in the black plastic block through which the wires from A1 pass to A2. Each ferrite bead increases the self-inductance of the wire passing through the bead, causing this portion of wire to act as an RF choke. The result is to minimize RF feedthrough to the A2 input amplifier assembly.

52. The dc output from the bulkhead assembly is applied to the two field-effect transistors (FET's) in A2U1. These transistors function as a sampling gate (or chopper). The sampling rate is controlled by a 220 Hz square wave supplied by the power meter. The sampling gate output (at pin 3 of A2U1) is a 220 Hz square wave having a voltage proportional to the RF power input.

53. The output of A2U1 is amplified about 700 times by an operational amplifier made up of A2Q1 and the first amplifier stage in the power meter. Figure 5 is a simplified diagram of the complete operational amplifier.

54. The Auto Zero Feedback circuit is coupled to the Power Sensor from the Power Meter. The dc voltage used to set the zero level is applied to the input of FET A2U1Q1 by using A2R1 and the series resistance of the thermocouple A1TC1 as a voltage divider.

55. When the Power Sensor is used with the HP 436A Power Meter, the short at J1-K (MOUNT RESISTOR) indicates the type of power sensor in use. As a result, the power meter automatically selects the proper measurement range (—30 to +20 dBm). With the HP 435 series Power Meter, this short serves no function.

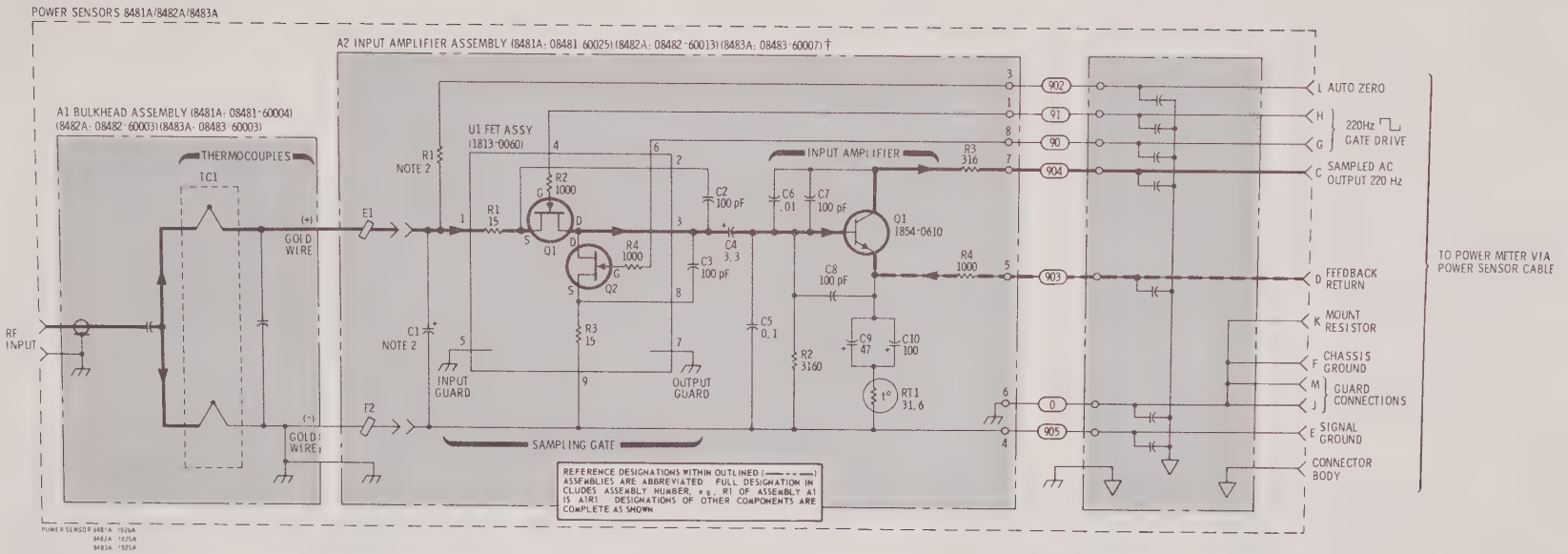
56. Troubleshooting

57. The troubleshooting information which follows is intended to isolate a problem to a stage. The defective component can then be identified by voltage and resistance checks. The field-effect transistors (FET's) in A2U1 are slightly light sensitive. As a result, dc levels are shifted slightly when the FET's are exposed.

CAUTION

Be extremely careful when measuring across the gold wires. They are delicate and can be damaged easily.

58. The A1 bulkhead assembly normally supplies +12 ± 3 mV when the RF input is 100 mW. Measure this voltage at A2U1 pin 1. This dc voltage will vary somewhat if the A2 input amplifier is inoperative, or if the bulkhead assembly is disconnected from the input amplifier. Resistance measured across the two gold wires leading to the A2 assembly should be 200 ± 10 ohms (8481A), 245 ± 12.5 ohms (8482A) or 375 ± 17.5 ohms (8483A).



NOTES

1. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN MICROFARADS.
2. THE VALUES OF COMPONENTS A2R1 AND A2C1 ARE AS FOLLOWS:
   - 8481A: A2R1 IS 464 KΩ, A2C1 IS 47 µF
   - 8482A: A2R1 IS 562 KΩ, A2C1 IS 39 µF
   - 8483A: A2R1 IS 787 KΩ, A2C1 IS 27 µF
3. A1 BULKHEAD ASSEMBLY IS NOT FIELD REPAIRABLE.
4. COMPONENTS OF THE J1 ASSEMBLY ARE NOT SEPARATELY REPLACEABLE.

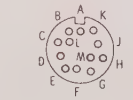
† REFER TO BACKDATING INFORMATION IN THE APPENDIX.

REFERENCE DESIGNATIONS

NO PREFIX	A2 ASSY
J1	C1-10
	CR1
	E1,2
	Q1
	R1-4
	RT1
	U1

U1 TOP VIEW

J1 MATING SIDE



CAUTION: DO NOT FORCE LARGE-DIAMETER TEST PRODS INTO THE PIN RECEPTACLES OF J1. THIS MAY PERMANENTLY DEFORM THE RECEPTACLES.

Figure 4. Schematic Diagram

Note that excessive power will damage the thermocouples and cause their resistance to increase. If the A1 Bulkhead Assembly is defective, the entire Bulkhead Assembly must be replaced.

59. The FET's in A2U1 may be checked by the following procedure:

a. Disconnect the cables from the Power Sensor.

b. Remove the upper chassis from the Power Sensor. (Refer to disassembly procedures, paragraph 68).

c. Measure the resistance between pins 1 and 2 of the A2U1. The resistance should be 15 ± 0.75 ohms. The same resistance should be found between pins 8 and 9 of A2U1.

d. Short pins 4, 6, and 9 of A2U1. While the pins are shorted, measure the resistance between pins 2 and 3, and between pins 3 and 8, of A2U1. The resistance should be less than 40 ohms.

e. Set a power supply to 10 Vdc.

f. Connect the positive side of the power source to the Power Sensor signal ground. Connect the negative power supply lead to pins 4 and 6 of A2U1.

g. Measure the resistance between pins 2 and 3 of A2U1. Also measure the resistance between pins 3 and 8 of A2U1. In both cases, the resistance should be several hundred times the resistance found in step d.

60. The 220 Hz drive from the power meter should have the following levels:

a. −0.05 ± 0.05 Vdc (top of square wave).

b. > −9 Vdc (bottom of square wave).

61. In most cases it may be assumed that the operational amplifier (made up of A2Q1 and the first amplifier in the power meter) is operating correctly if the dc voltage on the metal cover of A2Q1 (collector) is −70 ± 30 mVdc.

62. REPAIR

63. Cleanliness

64. Do not handle the A2 input amplifier circuit board more than necessary. Dirt or moisture from the hands may make the circuits inoperative. Do not use solder-flux remover on the circuit board. It is particularly important to keep the area around A2U1 clean.

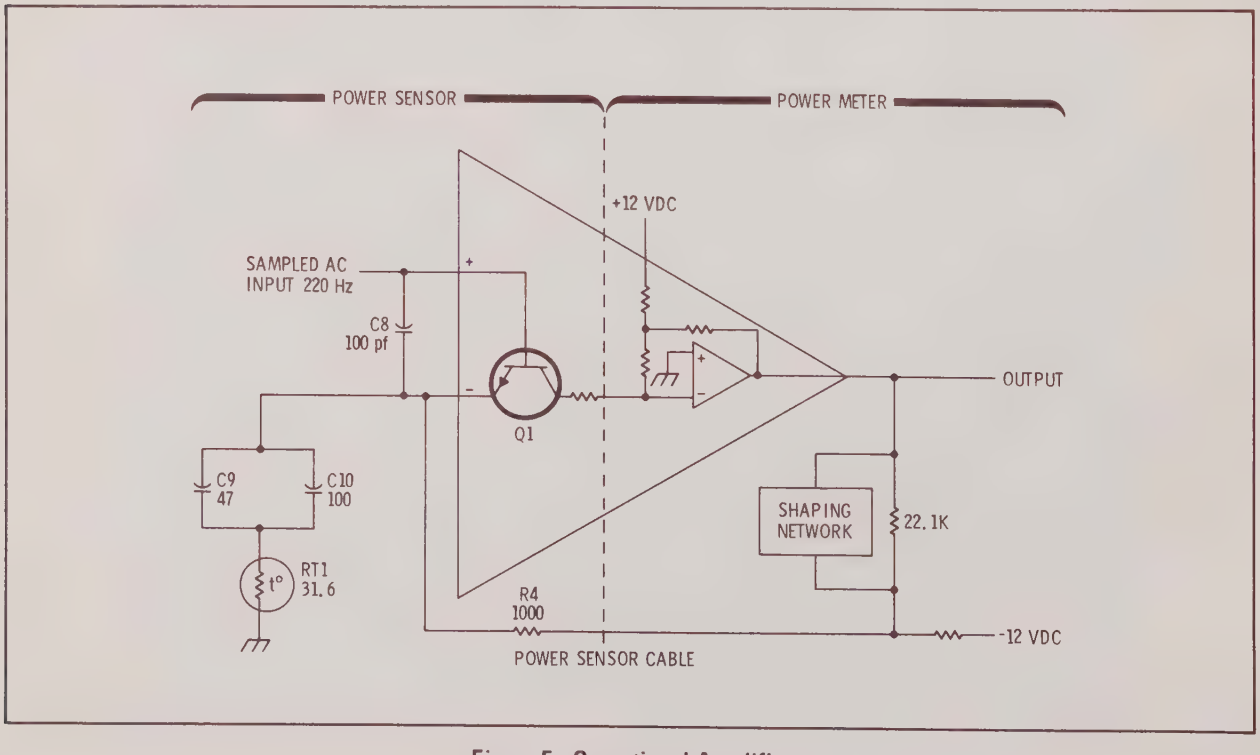


Figure 5. Operational Amplifier

65. Soldering Techniques

66. The Power Sensor is a high-sensitivity device, and is affected by very small differences in temperature between its components. Therefore, after the performance of any soldering in the unit, several hours must be allowed for the unit to reach thermal equilibrium before it is used or tested.

67. Capacitors A2C2, A2C3, A2C7, and A2C8 (Figure 3) require low-temperature soldering techniques. The connections to these capacitors are a gold film deposited on a ceramic base. Molten solder results in the gold forming an amalgam with the solder, and the consequent removal of the gold from its ceramic base. Soldering must be done quickly, and a low-temperature soldering iron and solder must be used. The capacitors must be discarded if unsoldered. If integrated circuit A2U1 or transistor A2Q1 is replaced, two of these capacitors must be removed, and therefore must be replaced with new ones. The required low-temperature soldering iron and solder are as follows:

a. Hexacon Thermo-O-Trac soldering iron with J206X tip, temperature 600° F (311°C).

b. Low-temperature solder SN 62, HP part number 5090-0410.

68. Disassembly Procedures

CAUTIONS

Disassembly must be performed in the sequence described below, otherwise damage may be caused to the two gold wires between the A1 bulkhead assembly and the A2 input amplifier assembly. If these wires are damaged, the A1 bulkhead assembly must be returned to the factory for repair.

Each Power Sensor has an individually prepared graph on the housing. If more than one Power Sensor is disassembled, be sure to use the proper housing for each when they are reassembled.

69. Disassemble the Power Sensor by performing the following steps:

CAUTION

The gold wires connecting the A1 Bulkhead Assembly and the A2 Input Amplifier Assembly are extremely delicate and may be easily broken. Be careful when working around them.

(Caution cont'd)

a. Insert the blade of a small screwdriver between the two-piece plastic shell at the rear of the Power Sensor. Gently pry the sections apart. (See Figure 6).

b. Proceed to the other side of the connector and again pry the cover sections apart. Remove the shells and magnetic shields.

c. Position the Power Sensor as shown in Figure 7 (top). The small hole ❺ should be on the left side of the RF input connector. Remove the allen cap screws ❶, ❷, ❿, and ⓭. Loosen ⓫ and ⓬. Remove the upper chassis from the Power Sensor.

d. Remove the spring clamp cap screw ❼ to free the gold leads which come from the Bulkhead Assembly.

e. Remove cap screws ❸, ❹, and ❻.

f. Slide the Bulkhead Assembly straight out from the chassis.

g. Remove cap screws ❽, ❾, ⓫, ⓬, ⓮, and ⓯.

e. Lift the A2 Input Amplifier and J1 connector out of the chassis.

70. Reassembly Procedures

CAUTION

The gold wires connecting the A1 Bulkhead Assembly and the A2 Input Amplifier Assembly are extremely delicate and may be easily broken. Be careful when working around them.

a. Place the printed circuit board and connector into place.

b. Cap screws ❽, ❾, ⓫, ⓬, ⓮, and ⓯ must be inserted but not tightened. Refer to Figure 7.

c. Center the circuit board so there is equal air gap between each side and the chassis. Tighten ❽, ❾, ⓮, and ⓯.

d. With small hole (5) to the left, carefully insert the gold leads on A1 bulkhead assembly through the holes in the black plastic guide on A2 input amplifier.

e. Insert screws (3), (4), and (6). Tighten only screw (6).

f. Position the ends of the gold wires over the pads on A2U1. The wires should not pass over the hole in the pad. Lightly clamp the leads in place with screw (7). DO NOT fully compress the spring.

g. Place the upper chassis in position and insert cap screws (1), (2), (10), and (13).

h. Tighten (1), (2), (3), and (4).

i. Tighten (10), (11), (12), and (13).

j. Place the plastic shells, magnetic shields, and the chassis together as shown in Figure 2. Snap the plastic shells together.

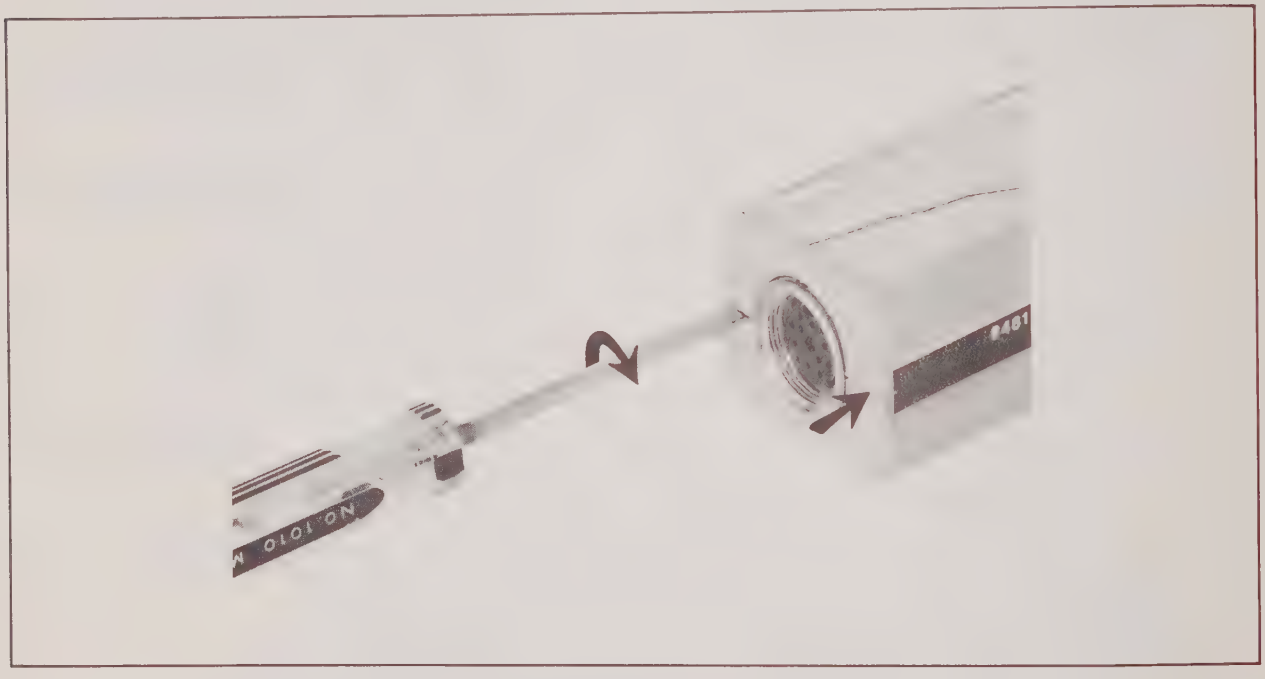


Figure 6. Removing the Power Sensor's Cover

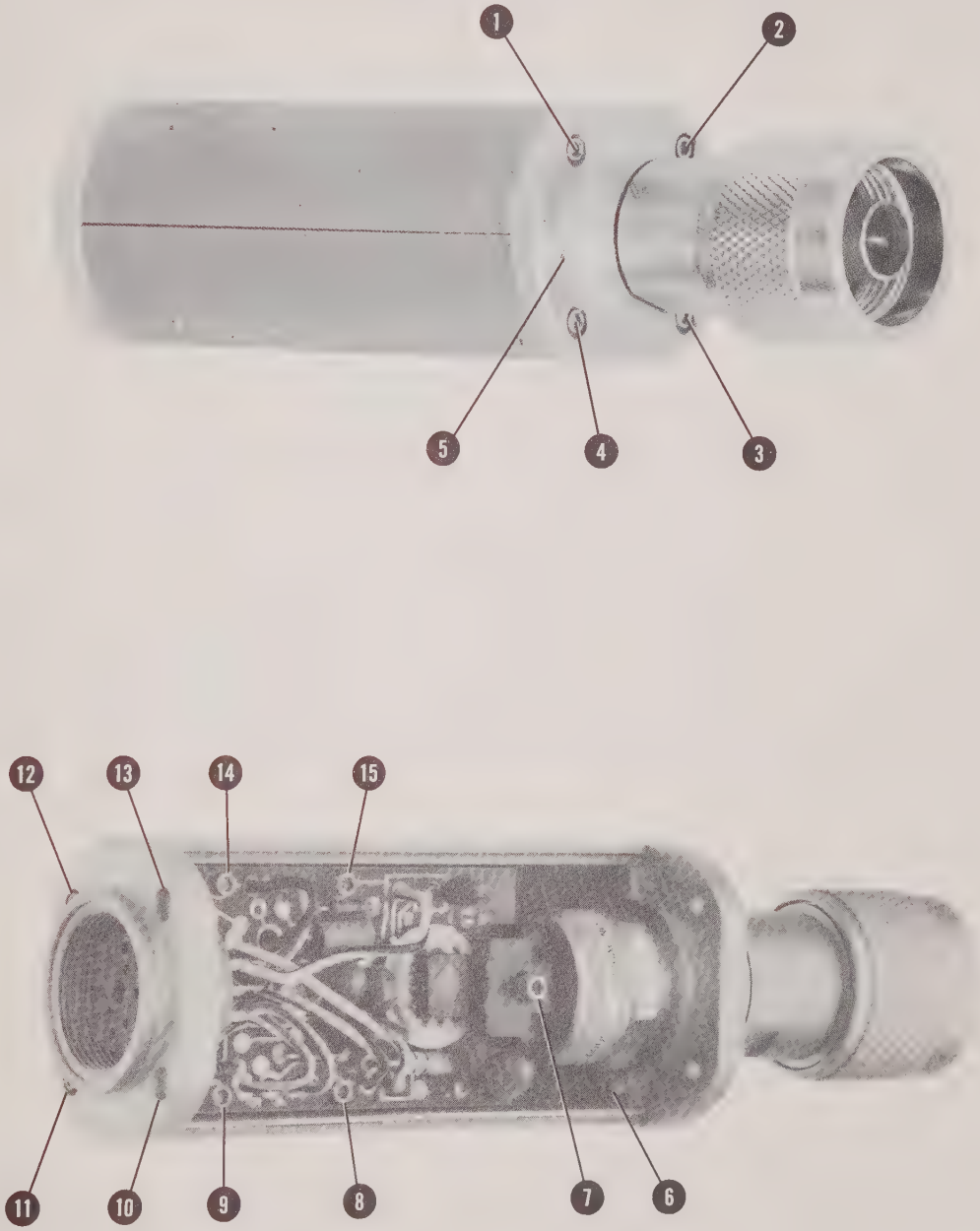


Figure 7. Power Sensor Hardware Locations

APPENDIX I

MANUAL CHANGES

This Appendix contains information for adapting this manual to instruments for which the content does not apply directly.

To adapt this manual to your instrument, refer to Table I-1 and make the changes listed opposite your instrument serial number.

Table I-1. Manual Changes by Serial Number.

Serial Prefix or Number	Make Manual Changes
8481A:1550A	A
8482A:1551A	A
8483A:1602A	A

CHANGE INSTRUCTIONS

CHANGE A

Page 8, Table 5:

Change A2 part numbers as follows:

08481-60025 to 08481-60017

08482-60013 to 08482-60005

08483-60007 to 08483-60004

Change J1 to 1251-3228 CONNECTOR, 12 PIN FEMALE MULTICONTACT 90949 91T-3638.

Page 10, Figure 4:

Replace Figure 4 with Figure I-1.

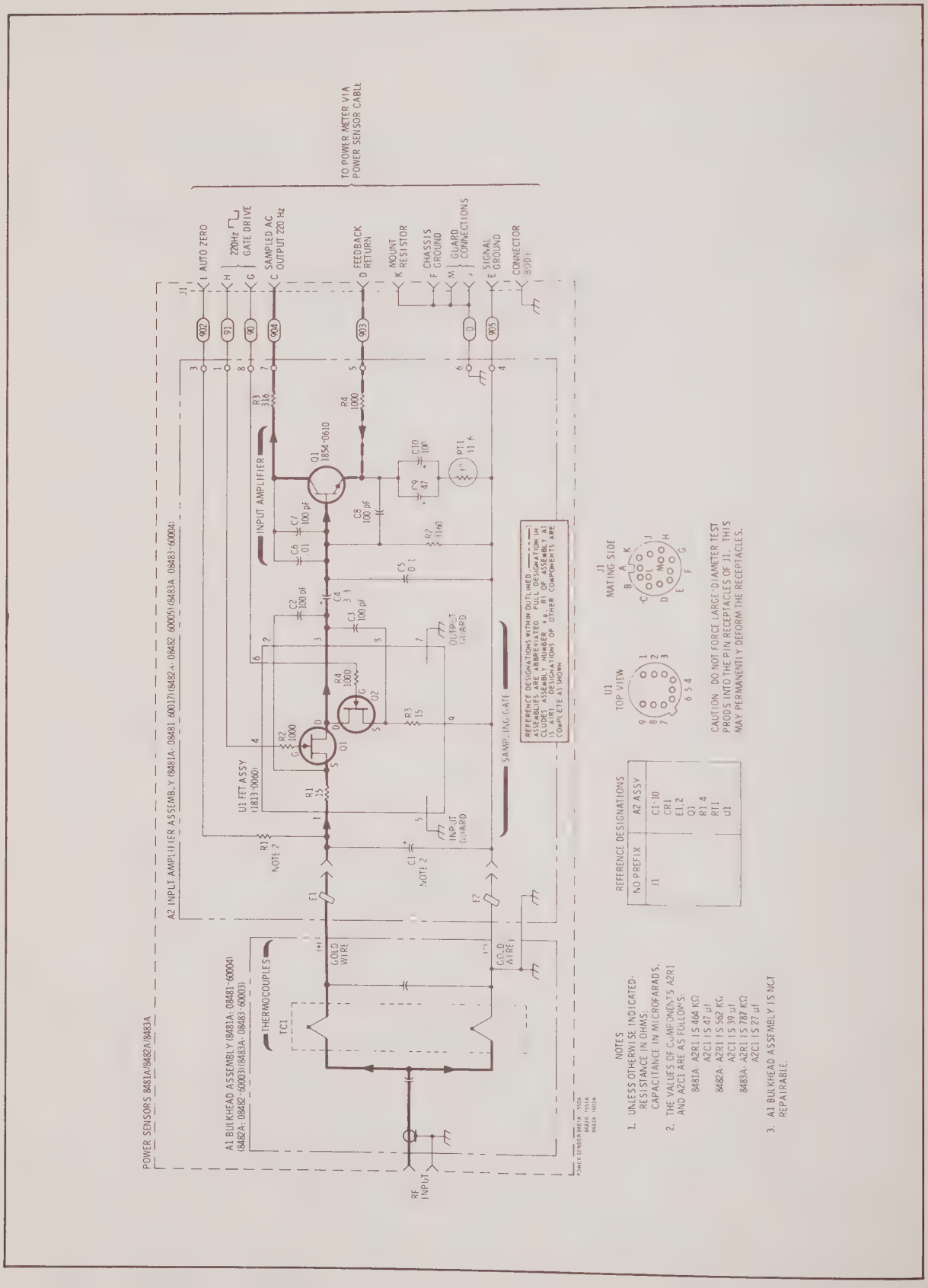

POWER SENSORS 8481A/8482A/8483A
A2 INPUT AMPLIFIER ASSEMB. Y (8483A: 08481-60017)(8482A: 08462-60005)(8483A: 08483-60004)
A1 BULKHEAD ASSEMBLY (8481A: 08481-60004) (8482A: 08482-60003)(8483A: 08483-60003)
THERMOCOUPLES
TC1
COLD WIRE
U1 FET ASSY (1813-0060)
INPUT AMPLIFIER
SAMP. INC GATE
INPUT GUARD
OUTPUT GUARD
REFERENCE DESIGNATIONS WITHIN OUTLINED AREA ARE ABBREVIATED. FULL DESIGNATION (INCLUDES ASSEMBLY NUMBER e.g. A1 OF ASSEMBLY A1 IS A1R1) DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN
RF INPUT
TO POWER METER VIA POWER SENSOR CABLE
J1
1 AUTO ZERO
H 220Hz GATE DRIVE
G
C SAMPLED AC OUTPUT 220 Hz
D FEEDBACK RETURN
K MOUNT RESISTOR
F CHASSIS GROUND
M GUARD CONNECTIONS
J
E SIGNAL GROUND
CONNECTOR 8120-1
U1 TOP VIEW
J1 MATING SIDE
NOTES
1. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN MICROFARADS.
2. THE VALUES OF COMPONENTS A2R1 AND A2C1 ARE AS FOLLOWS:
8481A: A2R1 IS 464 KΩ
A2C1 IS 47 µf
8482A: A2R1 IS 562 KΩ
A2C1 IS 39 µf
8483A: A2R1 IS 787 KΩ
A2C1 IS 27 µf
3. A1 BULKHEAD ASSEMBLY IS NOT REPAIRABLE.
REFERENCE DESIGNATIONS
NO PREFIX
A2 ASSY
J1
C1-10
CR1
E1,2
Q1
R1-4
RT1
U1
CAUTION: DO NOT FORCE LARGE-DIAMETER TEST PRODS INTO THE PIN RECEPTACLES OF J1. THIS MAY PERMANENTLY DEFORM THE RECEPTACLES.

Figure I-1. Schematic Diagram (P/O Change A)

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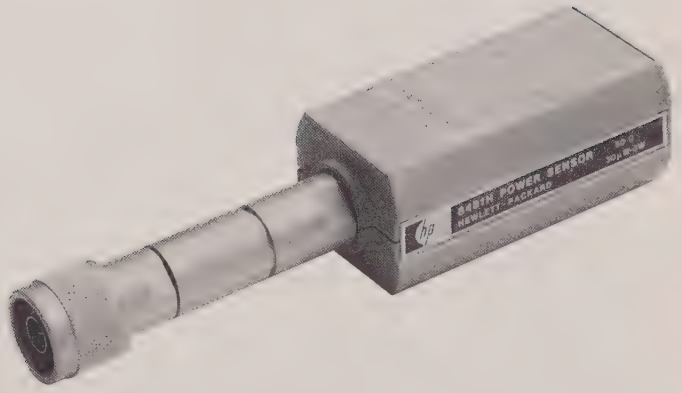

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The Hewlett-Packard Company certifies that this instrument met its published specifications at the time of shipment from the factory. Hewlett-Packard Company further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

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    Lawndale, CA 90260
  - GEORGIA
    450 Interstate N. Parkway
    Atlanta, GA 30348
  - ILLINOIS
    5201 Tollview Dr.
    Rolling Meadows, IL 60008
  - NEW JERSEY
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  Blackburn, Victoria 3130
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  3200 Hillview Avenue
  Palo Alto, CA 94304

MANUAL IDENTIFICATION

Model Number: 8481H/8482H
Date Printed: January 1979
Part Number: 08481-90016

POWER SENSOR

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections

Make all appropriate serial number related changes indicated in the tables below.

8481H	
Serial Prefix or Number	Make Manual Changes
1925A	1

8482H	
Serial Prefix or Number	Make Manual Changes
1926A	1

► NEW ITEM

ERRATA

Page 7, Table 4:

The recommended replacement part for J1 is 08481-60024. See Change 1.
Add MP27 7120-8714 (CD=2) LABEL-INFORMATION.
►Add MP28, 7121-2422, Label-Caution, CD9, quantity 1 (8481H and 8482H).

Continued . . .

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

12 February 1982
2 Pages

HEWLETT PACKARD

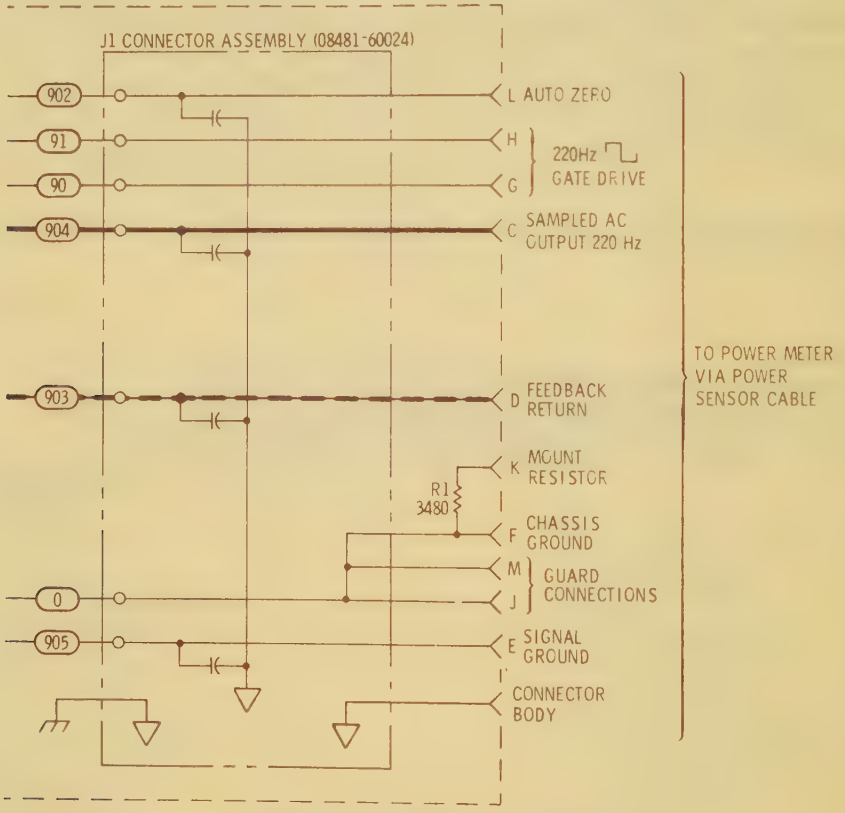
CHANGE 1

Page 7, Table 4:

Change A2 part number for 8481H to 08481-60025 (Check Digit is 4).
Change A2 part number for 8482H to 08482-60013 (Check Digit is 1).
Change J1 part number to 08481-60024 (Check Digit is 3).

Page 9, Figure 3:

Change A2 part number for 8481H to 08481-60025.
Change A2 part number for 8482H to 08482-60013.
Replace appropriate portion of schematic with the following partial schematic:



P/O Figure 3. Schematic Diagram (part of Change 1)

OPERATING AND SERVICE MANUAL

8481H
8482H
POWER SENSOR

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 1545A.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL on page 2.

HEWLETT PACKARD

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1501 PAGE MILL ROAD, PALO ALTO CALIFORNIA, U.S.A.

MANUAL PART NUMBER 08481-90016
Microfiche Part Number 08481-90017

Printed: JANUARY 1979

1. GENERAL INFORMATION

2. This Operating and Service Manual contains informaton about initial inspection, performance tests, adjustments, operation, troubleshooting and repair of the Model 8481H and 8482H Power Sensors.

3. On the title page of this manual is a "Microfiche" part number. This number can be used to order a 4 x 6-inch microfilm transparency of the manual.

4. Instruments Covered by Manual

5. This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form a sequential suffix which is unique to each instrument. The contents of this manual apply directly to instruments having the serial number prefix listed under SERIAL NUMBERS on the title page.

6. An instrument manufactured after the printing of this manual may have a serial prefix that is not listed on the title page. This unlisted serial prefix indicates that the manual for this instrument is supplied with a yellow Manual Changes supplement containing "change information" that documents the differences.

7. In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement is keyed to the manual print date and part number, both of which appear on the title page. Complimentary copies of the supplement are available on request from your nearest Hewlett-Packard office.

8. For information concerning a serial number prefix not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

9. Description

10. The Power Sensors are used for measuring the average power supplied by an RF source to a 50-ohm load. In use, the Power Sesnor is connected to the RF source and to a compatible power meter. (Suitable meters are the HP 435A or 436A Power Meter.) The Power Sensor places a 50-ohm load on the RF source, and the power meter indicates the power dissipated in this load. The power is determined from the RF voltage developed across the Power Sensor load, and is expressed in μW (or W) and dBm. The HP 436A Power Meter can also provide readings, in dB, relative to a previous RF input to the Power Sensor.

11. The Power Sensors measure power levels from −15 dBm to +35 dBm (30 μW to 3W), at frequencies from 10 MHz to 18 GHz (8481H) or 100 kHz to 4.2 GHz (8482H).

12. The physical configuration of both sensors is the same. However, because of the different frequency ranges covered, there are some changes in part numbers and component values.

13. Calibration data is provided by a graph on the Power Sensor. The graph, individually prepared for each Power Sensor, shows the calibration factor (CAL FACTOR) at 17 frequencies. This calibration factor is used to adjust the power meter to suit the particular Power Sensor and RF frequency. For greater accuracy, a table showing the calibration factor to two significant digits is supplied with each Power Sensor.

14. Specifications for the Power Sensor are provided in Table 1.

15. Option 002

16. Option 002 is a range knob for the HP 435A Power Meter, permitting more convenient use of power meters which have serial prefix number 1527A and under. HP 435A Power Meters with a higher serial prefix number do not require Option 002. No HP 436A Power Meter requires Option 002.

17. Recommended Test Equipment

18. Table 2 lists the test equipment recommended to check, adjust, and troubleshoot the Power Sensor. If substitute equipment is used, it must meet or exceed the critical specifications.

19. INSTALLATION

20. Initial Inspection

21. Inspect the shipping container. If the container or packing material is damaged it should be kept until the contents of the shipment have been

Table 1. Specifications

Frequency Range: 10 MHz to 18 GHz (8481H) , 100 kHz to 4.2 GHz (8482H)

Power Measurement Range: −10 dBm to +35 dBm (100 μW to 3W).

Maximum Permissible RF Power, Average: 3.5 W.

Maximum Permissible RF Power, Peak: 100W.

Maximum Energy/Pulse: 100 W/μs.

Maximum SWR (Reflection Coefficient) of Power Sensor:

8481H		8482H
1.20 (0.091)	10 MHz to 8 GHz	1.20 (0.091) 100 kHz to 4.2 GHz
1.25 (0.111)	8 GHz to 12.4 GHz	
1.30 (0.130)	12.4 GHz to 18 GHz	

RF Impedance: 50 ohms nominal.

RF Connector: Type N Male (meets military specifications).

Calibration: 8481H — Individual calibration graph and table, traceable to NBS, provided with each Power Sensor.
8482H — Individual calibration graph, traceable to NBS, provided with each Power Sensor.

Dimensions, including RF connector: 30 mm wide, 38 mm high, 149 mm long (1-3/16 x 1-1/2 x 5-7/8).

Weight: Net, 0.2 kg (8 oz.).

Table 2. Recommended Test Equipment

Instrument Type	Critical Specifications	Suggested Model	Use*
Digital Voltmeter	Range: 100 mVdc to 100 Vdc Input impedance: 10 megohms Resolution: 4-digit Accuracy: ±0.05% ± 1 digit	HP 3439A/3443A	T
Oscilloscope	Bandwidth: dc to 50 MHz Sensitivity: Vertical, 0.2V/div Horizontal, 1 ms/div	HP 180C/1801A/1821A	A, T
10:1 Divider Probe	10 Megohms 10 pF	HP 10004D	A
Ohmmeter	Range: 1 ohm to 100,000 ohms Accuracy: ±5%	HP 412A	T
DC Power Supply	Range: 0—20 Vdc Load Regulation: 0.01% + 4 mV	HP 6204B	T

*A = Adjustment, T = Troubleshooting.

checked mechanically and electrically. If there is mechanical damage or if the instrument does not pass the performance tests, notfiy the nearest Hewlett-Packard office. Keep the damaged shipping materials (if any) for inspection by the carrier and a Hewlett-Packard representative.

22. Storage and Shipment

23. Environment. The instrument should be stored in a clean, dry environment. The following limitations apply to both storage and shipment:

a. Temperature −40 to +75° C

b. Relative humidity, less than 95%

c. Altitude, less than 7,600 metres (25,000 feet).

24. Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of ser-

vice required, return address, model number, and serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and serial number.

25. INTERCONNECTIONS

26. Refer to the power meter operating and service manual for interconnecting instructions.

27. OPERATION

28. Environment

29. The operating environment for the Power Sensor should be as follows:

a. Temperature, 0° to 55°C

b. Relative humidity, less than 95%

c. Altitude, less than 4,572 metres (15,000 feet).

30. Operating Precautions

31. Before the Power Sensor is connected, the following precautions must be observed.

CAUTIONS

BEFORE CONNECTING THE POWER SENSOR TO ANOTHER INSTRUMENT, ensure that the instrument and power meter are connected to the protective (earth) ground.

Exceeding the energy and power levels shown in paragraph 32 may result in damage to the power meter system.

Do not apply torque to the Power Sensor's body while connecting or disconnecting the Type N RF connector.

32. The absolute maximum RF signal level that may be coupled to the Power Sensor is:

a. Maximum Average Power 3.5W

b. Maximum Peak Power 100W

c. Maximum Energy Per Pulse 100W/μs.

33. Calibration is performed as follows:

a. For the HP 435A Power Meter, set the RANGE switch to 1 mW, and adjust the CAL ADJ control to bring the needle on the meter to the CAL position.

b. For the HP 436A Power Meter, adjust the CAL ADJ control to obtain a reading of 1 mW on the digital display.

34. Operating Procedures

35. Instructions for use of the Power Sensor are provided in the power meter manual. Note, however, the different calibration procedure described in paragraph 33 above. During operation, the precautions in paragraph 31 must be observed.

36. SWR (REFLECTION COEFFICIENT) PERFORMANCE TEST

37. The maximum SWR and reflection coefficient for the Power Sensor are listed in Table 3. For making these measurements, use equipment which has measurement uncertainties not exceeding those shown in the table.

38. FET BALANCE ADJUSTMENT

39. The sampling gate balance is affected by the relative positions of the wires in the Power Sensor which connect to pins G and H of connector J1. One wire is black and white, and the other is brown and white. Once positioned, care must be used not to displace these wires.

40. To correctly position these wires, after replacement of A2U1, connect an oscilloscope as follows to display switching transients:

a. Test point A4TP4 in the HP 435A Power Meter, or

b. Test point A2TPAC (3) in the HP 436A Power Meter.

41. Adjust the black-and-white and brown-and-white wires until the switching transient amplitude is less than 0.8 Vp-p.

42. REPLACEABLE PARTS

43. Table 4 is a list of replaceable parts. Figure 1 illustrates the major parts. To order a part, quote the Hewlett-Packard part number, specify the quantity required, and address the order to the nearest Hewlett-Packard office. To order a part not

Table 3. SWR and Reflection Coefficient

Frequency	Measuring System Reflection Coefficient Uncertainty	Actual Measurement	Maximum SWR (Reflection) Coefficient)
	8481H		
10 MHz to 8 GHz	±0.025	_____	1.20 (0.91)
8 GHz to 12.4 GHz	±0.030	_____	1.25 (0.112)
12.4 GHz to 18 GHz	±0.035	_____	1.30 (0.130)
	8482H		
100 kHz to 4.2 GHz	±0.025	_____	1.20 (0.91)

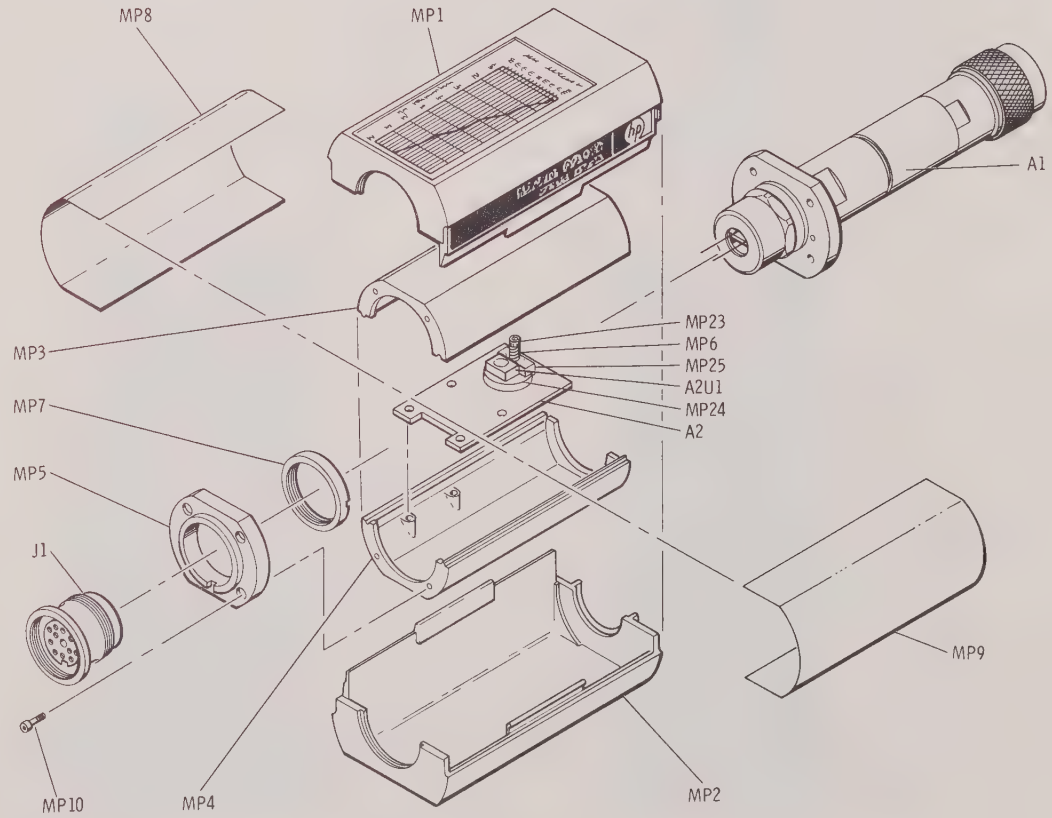


Figure 1. Illustrated Parts Breakdown

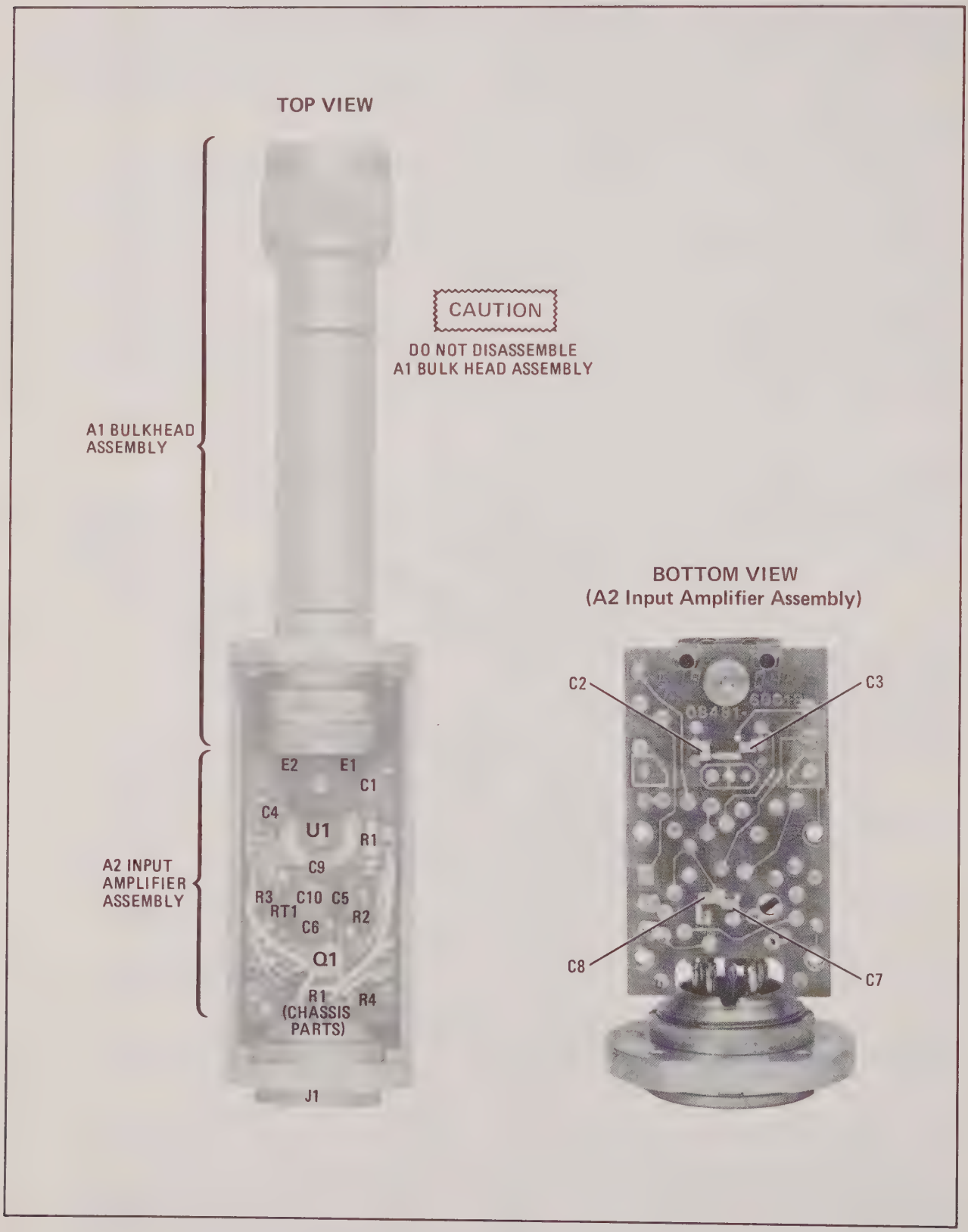


Figure 2. Component and Assembly Locations

Table 4. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	08481-60014	5	1	20 DB BULKHEAD TYPE N (FOR 8481H ONLY)	28480	08481-60014
A1	08682-60009	1	1	20 DB BULKHEAD TYPE N (FOR 8482H ONLY)	28480	08682-60009
A2	08481-60017	8	1	BOARD ASSEMBLY, POWER SENSOR (FOR 8481H ONLY)	28480	08481-60017
A2	08482-60005	5	1	BOARD ASSEMBLY, POWER SENSOR (FOR 8482H ONLY)	28480	08482-60005
A2C1	0180-2515	8	2	CAPACITOR-FXD 47UF+-20% 6VDC TA (FOR 8481H ONLY)	28480	0180-2515
A2C1	0180-0555	2	1	CAPACITOR-FXD 39UF+-20% 10VDC TA (FOR 8482H ONLY)	28480	0180-0555
A2C2	0160-4306	7	4	CAPACITOR-FXD 100PF +-10% 100VDC CER	28480	0160-4306
A2C3	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	28480	0160-4306
A2C4	0180-0594	9	1	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	14433	TAG-10-3.3/16-20
A2C5	0160-3094	8	1	CAPACITOR-FXD .1UF +-10% 100VDC CER	28480	0160-3094
A2C6	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C7	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	28480	0160-4306
A2C8	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	28480	0160-4306
A2C9	0180-2515	8		CAPACITOR-FXD 47UF+-20% 6VDC TA	28480	0180-2515
A2C10	0180-2545	4	1	CAPACITOR-FXD 100UF+-20% 4VDC TA	28480	0180-2545
A2Q1	1854-0610	0	1	TRANSISTOR NPN SI TO-46 FT=800MHZ	28480	1854-0610
A2R1	0698-3260	9	1	RESISTOR 464K 1% .125W F TC=0+-100 (FOR 8184H ONLY)	28480	0698-3260
A2R1	0757-0483	8	1	RESISTOR 562K 1% .125W F TC=0+-100 (FOR 8482H ONLY)	28480	0757-0483
A2R2	0698-7248	1	1	RESISTOR 3.16K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3161-G
A2R3	0698-7224	3	1	RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-T0-316R-G
A2R4	0698-7236	7	1	RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-G
A2RT1	0811-3210	1	1	RESISTOR 31.6 5% .05W PWW TC=+5040+-252	14140	1409-1/20-31R6-J
A2U1	1813-0060	8	1	IC, N88108	28480	1813-0060
				A2 MISCELLANEOUS PARTS		
	0590-1040	1	1	THREADED INSERT-NUT 0-80 .06-LG SST	28480	0590-1040
	5040-6938	6	1	SPACER	28480	5040-6938
				CHASSIS PARTS		
J1	1251-3228	4	1	CONNECTOR 12-PIN F CIRC AUDIO	28480	1251-3228
MP1	08481-40002	9	2	SHELL,PLASTIC	28480	08481-40002
MP2	08481-40002	9		SHELL,PLASTIC	28480	08481-40002
MP3	08481-20011	8	2	CHASSIS	28480	08481-20011
MP4	08481-20011	8		CHASSIS	28480	08481-20011
MP5	08481-20008	3	1	END BELL	28480	08481-20008
MP6	1460-1224	9	1	SPRING-CPRSN .088-IN-OD .188-IN-DIA-LG	28480	1460-1224
MP7	1251-3363	8	1	NUT,CONN,RND SPANNER NUT,AUDIO TYPE CONN	28480	1251-3363
MP8	08481-00002	5	2	SHIELD	28480	08481-00002
MP9	08481-00002	5		SHIELD	28480	08481-00002
MP10	3030-0422	8	13	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP11	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP12	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP13	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP14	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP15	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP16	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP17	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP18	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP19	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP20	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP21	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP22	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP23	3030-0436	4	1	SCREW-SKT HD CAP 0-80 .5-IN-LG SST-300	00000	ORDER BY DESCRIPTION
MP24	5040-6939	7	1	CLAMP	28480	5040-6939
MP25	5040-6940	0	1	BLOCK	28480	5040-6940
MP26	7120-5101	5	1	LABEL, ID (FOR 8481H ONLY)	28480	7120-5101
MP26	7120-5102	6	1	LABEL, ID (FOR 8482H ONLY)	28480	7120-5102
R1	0698-7249	2	1	RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-G

See introduction to this section for ordering information
*Indicates factory selected value

Table 5. Code List of Manufacturers

Mfr. No.	Manufacturer Name	Address	Zip Code
00000	ANY SATISFACTORY SUPPLIER		
02660	AMPHENOL SALES DIV OF BUNKER-RAMO	BROADVIEW, IL	60153
14140	EDISON ELEK DIV MCGRAW-EDISON	MANCHESTER, NH	03130
14433	ITT SEMICONDUCTORS DIV OF ITT CORP	PALM BEACH, FL	33401
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD, PA	16701
28480	HEWLETT-PACKARD CO. CORPORATE HQ	PALO ALTO, CA	94304

listed in Table 4, give the instrument model number, instrument serial number, the description and function of the part, and the quantity of parts required.

44. SERVICE

45. Test equipment which meets or exceeds the critical specifications in Table 2 may be used in place of the recommended instruments for troubleshooting the Power Sensor.

46. Figure 2 shows the locations of the assemblies and components. Figure 3 is the schematic diagram.

47. Principles of Operation

48. Bulkhead assembly A1 presents a 50-ohm load to the RF signal applied to the power sensor. The RF signal absorbed by the thermocouples generates a dc voltage that is proportional to the RF input power.

49. Components A2E1 and A2E2 are ferrite beads situated in the black plastic block through which the wires from A1 pass to A2. Each ferrite bead increases the self-inductance of the wire passing through the bead, causing this portion of wire to act as an RF choke. The result is to minimize rf feedthrough to the A2 input amplifier assembly.

50. The dc output from the bulkhead assembly is applied to the two field-effect transistors (FET's) in A2U1. These transistors function as a sampling gate (or chopper). The sampling rate is controlled by a 220 Hz square wave supplied by the power meter. The sampling gate output (at pin 3 of A2U1) is a 220 Hz square wave having a voltage proportional to the RF power input.

51. The output of A2U1 is amplified about 700 times by an operational amplifier made up of A2Q1 and the first amplifier stage in the power meter. Figure 4 is a simplified diagram of the complete operational amplifier.

52. The Auto Zero Feedback circuit is coupled to the Power Sensor from the Power Meter. The dc voltage used to set the zero level is applied to the input of FET A2U1Q1 by using A2R1 and the series resistance of the thermocouple A1TC1 as a voltage divider.

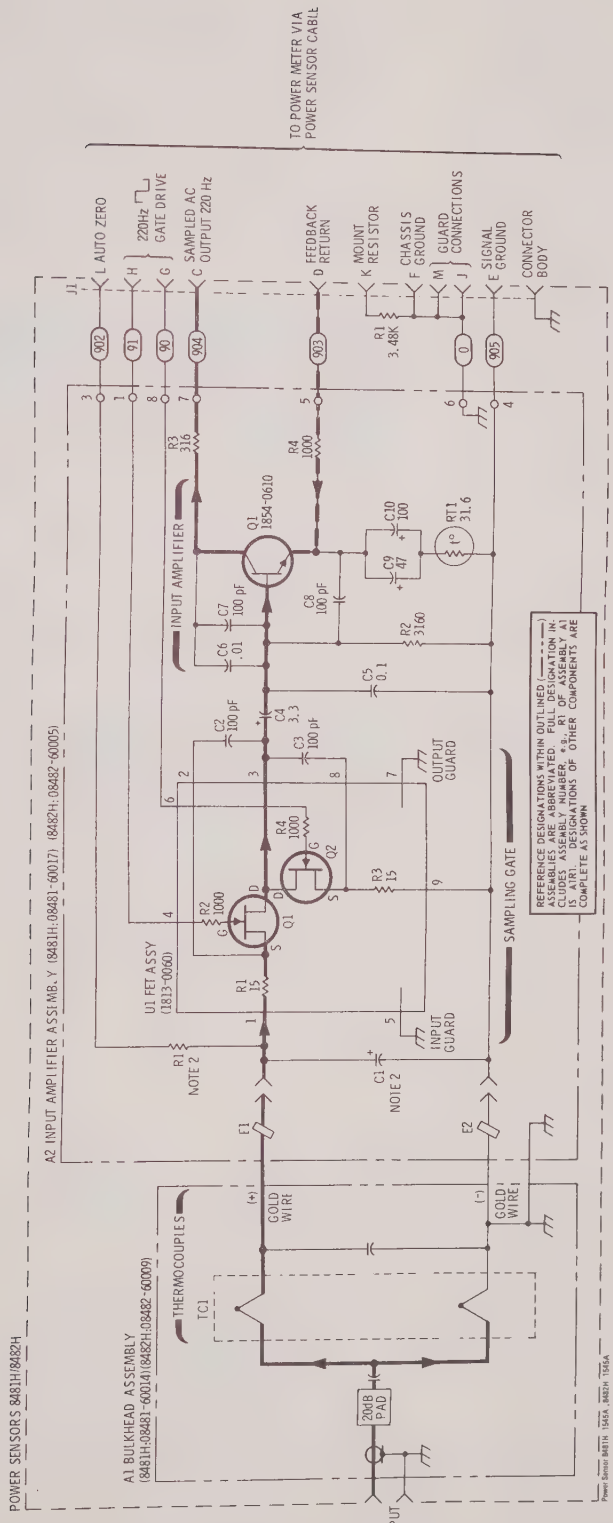
53. When the Power Sensor is used with the HP 436A Power Meter, the resistance of R1 indicates the type of power sensor in use. As a result, the power meter automatically selects the proper measurement range. The 3.48K ohm resistance of R1 causes selection of the −15 to +35 dBm range. With the HP 435A Power Meter, R1 serves no function.

54. Troubleshooting

55. The troubleshooting information which follows is intended to isolate a problem to a stage. The defective component can then be identified by voltage and resistance checks. The field-effect transistors (FET's) in A2U1 are slightly light sensitive. As a result, dc levels are shifted slightly when the FET's are exposed.

CAUTION

Be extremely careful when measuring across the gold wires. They are delicate and can be damaged easily.


POWER SENSORS 8481H/8482H
A2 INPUT AMPLIFIER ASSEMBLY (8481H:08481-60017) (8482H:08482-60005)
A1 BULKHEAD ASSEMBLY (8481H:08481-60014)(8482H:08482-60009)
THERMOCOUPLES
TC1
GOLD WIRE
U1 FET ASSY (1813-0060)
INPUT AMPLIFIER
SAMPLING GATE
INPUT GUARD
OUTPUT GUARD
20dB PAD
RF INPUT
L AUTO ZERO
220Hz GATE DRIVE
SAMPLED AC OUTPUT 220 Hz
FEEDBACK RETURN
MOUNT RESISTOR
CHASSIS GROUND
GUARD CONNECTIONS
SIGNAL GROUND
CONNECTOR BODY
TO POWER METER VIA POWER SENSOR CABLE
REFERENCE DESIGNATIONS WITHIN OUTLINED (——— ---) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER. R1 ON ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN
U1 TOP VIEW
J1 MATING SIDE
CAUTION: DO NOT FORCE LARGE-DIAMETER TEST PRODS INTO THE PIN RECEPTACLES OF J1. THIS MAY PERMANENTLY DEFORM THE RECEPTACLES.

NOTES

1. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN MICROFARADS.
2. THE VALUES OF RESISTOR A2R1 AND A2C1 ARE AS FOLLOWS:
   8481H: A2R1 IS 464 KΩ
   A2C1 IS 47μf
   8482H: A2R1 IS 562 KΩ
   A2C1 IS 39μf
3. A1 BULKHEAD ASSEMBLY IS NOT REPAIRABLE.

REFERENCE DESIGNATIONS

NO PREFIX	A2 ASSY
J1	C1-10
R1	CR1
	E1,2
	Q1
	R1-4
	RT1
	U1

Figure 3. Schematic Diagram

56. The A1 bulkhead assembly normally supplies +3.79 ± 1 mV when the RF input is 3W. Measure this voltage at A2U1 pin 1. This dc voltage will vary somewhat if the A2 input amplifier is inoperative, or if the bulkhead assembly is disconnected from the input amplifier. Resistance measured across the two gold wires leading to the A2 assembly should be 200 ± 10 ohms (8481H) or 245 ± 12.5 ohms (8482H). Note that excessive power will damge either the 20 dB pad or the thermocouples. If the 20 dB pad is damaged it will present an open circuit to the input signal. If the thermocouples are damaged their resistance will increase. If the A1 Bulkhead Assembly is defective, the entire Bulkhead Assembly must be replaced.

57. The FET's in A2U1 may be checked by the following procedure:

a. Disconnect the cables from the Power Sensor.

b. Remove the upper chassis from the Power Sensor. (Refer to disassembly procedures, paragraph 66).

c. Measure the resistance between pins 1 and 2 of the A2U1. The resistance should be 15 ± 0.75 ohms. The same resistance should be found between pins 8 and 9 of A2U1.

d. Short pins 4, 6, and 9 of A2U1. While the pins are shorted, measure the resistance between pins 2 and 3, and between pins 3 and 8, of A2U1. The resistance should be less than 40 ohms.

e. Set a power supply to 10 Vdc.

f. Connect the positive side of the power source to the Power Sensor signal ground. Connect the negative power supply lead to pins 4 and 6 of A2U1.

g. Measure the resistance between pins 2 and 3 of A2U1. Also measure the resistance between pins 3 and 8 of A2U1. In both cases, the resistance should be several hundred times the resistance found in step d.

58. The 220 Hz drive from the power meter should have the following levels:

a. −0.05 ± 0.05 Vdc (top of square wave).

b. > −9 Vdc (bottom of square wave).

59. In most cases it may be assumed that the operational amplifier (made up of A2Q1 and the first amplifier in the power meter) is operating correctly if the dc voltage on the metal cover of A2Q1 (collector) is −70 ± 30 mVdc.

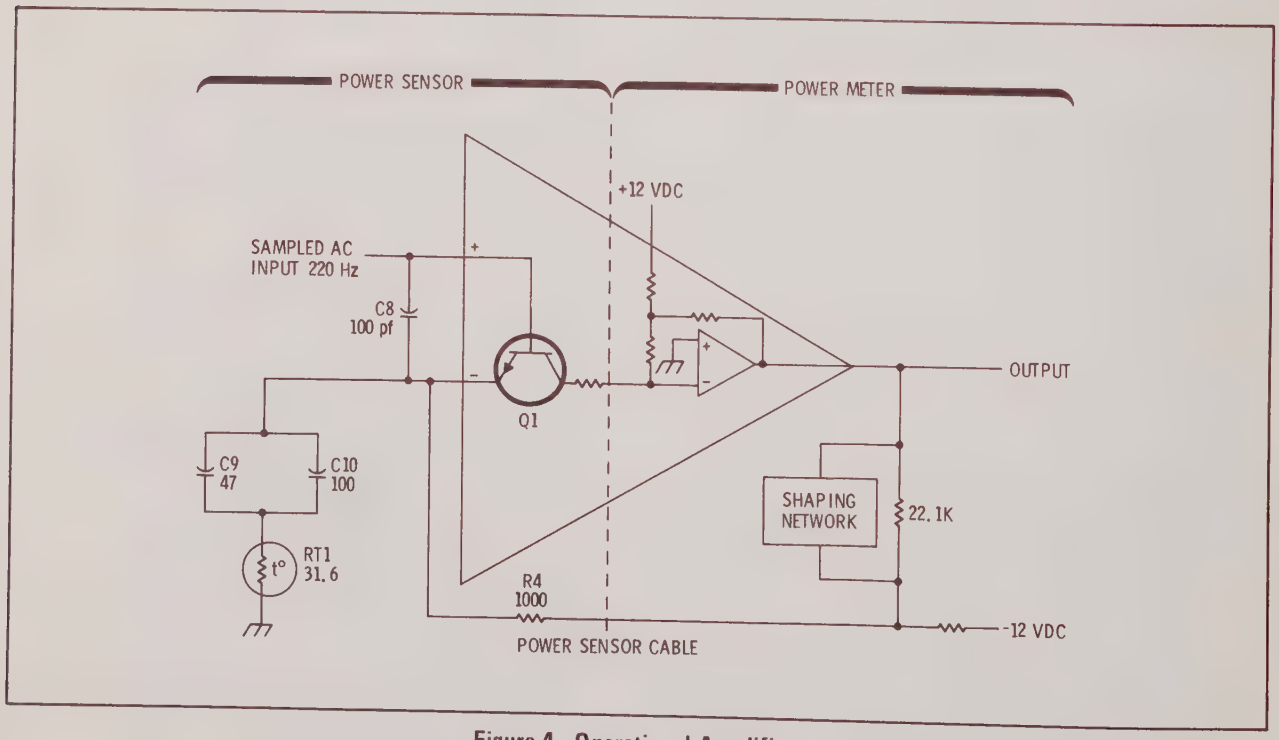


Figure 4. Operational Amplifier

60. REPAIR

61. Cleanliness

62. Do not handle the A2 input amplifier circuit board more than necessary. Dirt or moisture from the hands may make the circuits inoperative. Do not use solder-flux remover on the circuit board. It is particularly important to keep the area around A2U1 clean.

63. Soldering Techniques

64. The Power Sensor is a high-sensitivity device, and is affected by very small differences in temperature between its components. Therefore, after the performance of any soldering in the unit, *several hours* must be allowed for the unit to reach thermal equilibrium before it is used or tested.

65. Capacitors A2C2, A2C3, A2C7, and A2C8 (Figure 2) require low-temperature soldering techniques. The connections to these capacitors are a gold film deposited on a ceramic base. Molten solder results in the gold forming an amalgam with the solder, and the consequent removal of the gold from its ceramic base. Soldering must be done quickly, and a low-temperature soldering iron and solder must be used. The capacitors must be discarded if unsoldered. If integrated circuit A2U1 or transistor A2Q1 is replaced, two of these capacitors must be removed, and therefore must be replaced with new ones. The required low-temperature soldering iron and solder are as follows:

a. Hexacon Thermo-O-Trac soldering iron with J206X tip, temperature 600° F (311°C).

b. Low-temperature solder SN 62, HP part no. 5090-0410.

66. Disassembly Procedures

CAUTIONS

Disassembly must be performed in the sequence described below, otherwise damage may be caused to the two gold wires between the A1 bulkhead assembly and the A2 input amplifier assembly. If these wires are damaged, the A1 bulkhead assembly must be returned to the factory for repair.

Each Power Sensor has an individually prepared graph on the housing. If more than one Power Sensor is disassembled, be sure to use the proper housing for each when they are reassembled.

67. Disassemble the Power Sensor by performing the following steps:

CAUTION

The gold wires connecting the A1 Bulkhead Assembly and the A2 Input Amplifier Assembly are extremely delicate and may be easily broken. Be careful when working around them.

a. Insert the blade of a small screwdriver between the two-piece plastic shell at the rear of the Power Sensor. Gently pry the sections apart. (See Figure 5.)

b. Proceed to the other side of the connector and again pry the cover sections apart. Remove the shells and magnetic shields.

c. Position the Power Sensor as shown in Figure 6 (top). The small hole ❺ should be on the left side of the RF input connector. Remove the allen cap screws ❶, ❷, ❿, and ⓭. Loosen ⓫ and ⓬. Remove the upper chassis from the Power Sensor.

d. Remove the spring clamp cap screw ❼ to free the gold leads which come from the Bulkhead Assembly.

e. Remove cap screws ❸, ❹, and ❻.

f. Slide the Bulkhead Assembly straight out from the chassis.

g. Remove cap screws ❽, ❾, ⓫, ⓬, ⓮, and ⓯.

e. Lift the A2 Input Amplifier and J1 connector out of the chassis.

68. Reassembly Procedures

CAUTION

The gold wires connecting the A1 Bulkhead Assembly and the A2 Input Amplifier Assembly are extremely delicate and may be easily broken. Be careful when working around them.

a. Place the printed circuit board and connector into place.

b. Cap screws 8, 9, 11, 12, 14, and 15 must be inserted but not tightened. Refer to Figure 6.

c. Center the circuit board so there is equal air gap between each side and the chassis. Tighten 8, 9, 14, and 15.

d. With small hole 5 to the left, carefully insert the gold leads on A1 bulkhead assembly through the holes in the black plastic guide on A2 input amplifier.

e. Insert screws 3, 4, and 6. Tighten only screw 6.

f. Position the ends of the gold wires over the pads on A2U1. The wires should not pass over the hole in the pad. Lightly clamp the leads in place with screw 7. DO NOT fully compress the spring.

g. Place the upper chassis in position and insert cap screws 1, 2, 10, and 13.

h. Tighten 1, 2, 3, and 4.

i. Tighten 10, 11, 12, and 13.

j. Place the plastic shells, magnetic shields, and the chassis together as shown in Figure 1. Snap the plastic shells together.

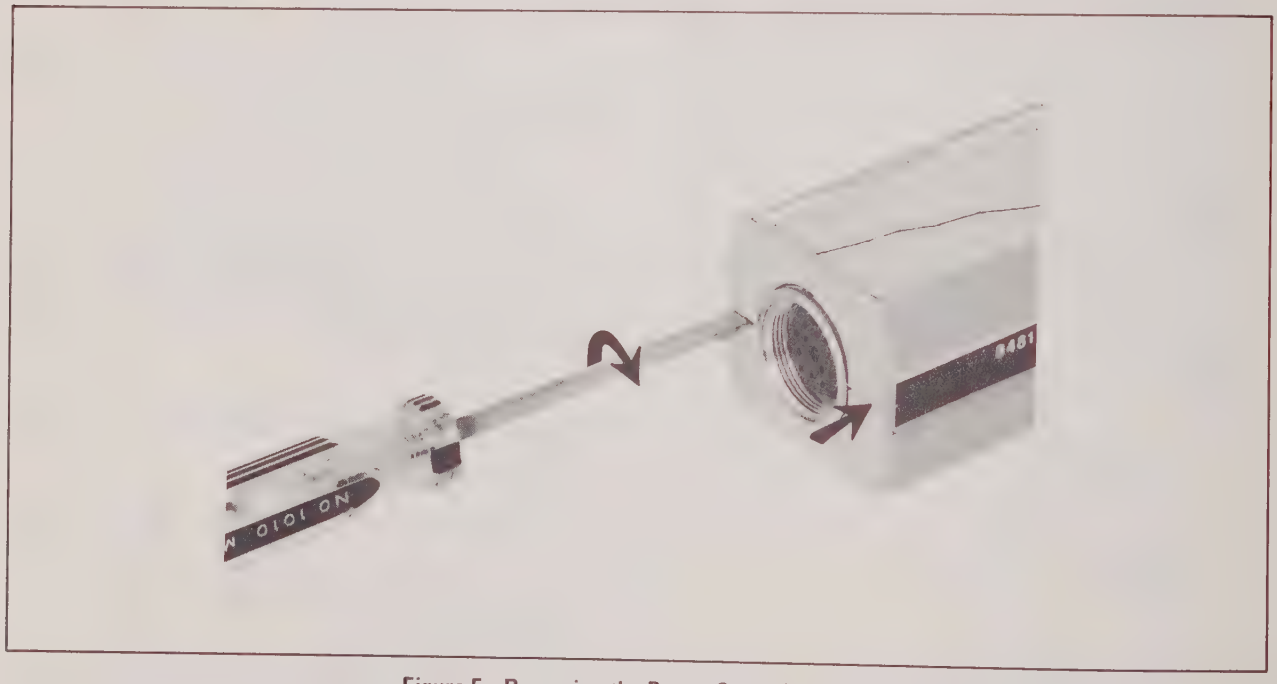
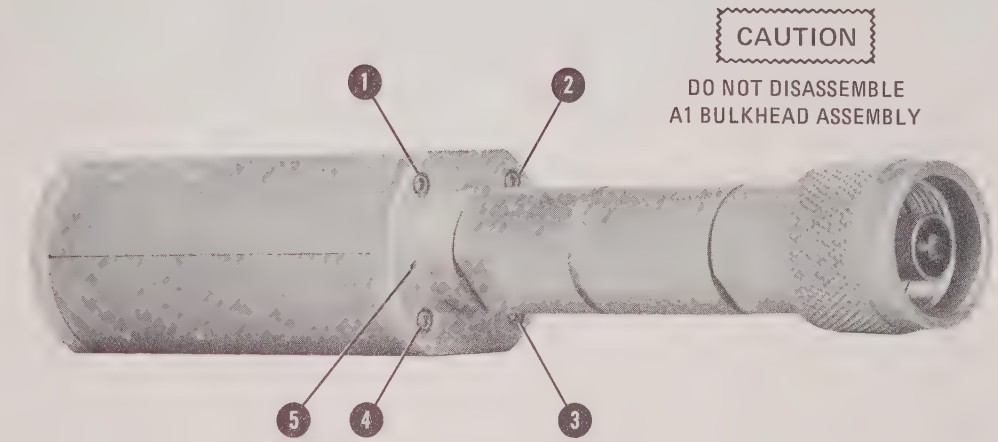


Figure 5. Removing the Power Sensor's Cover



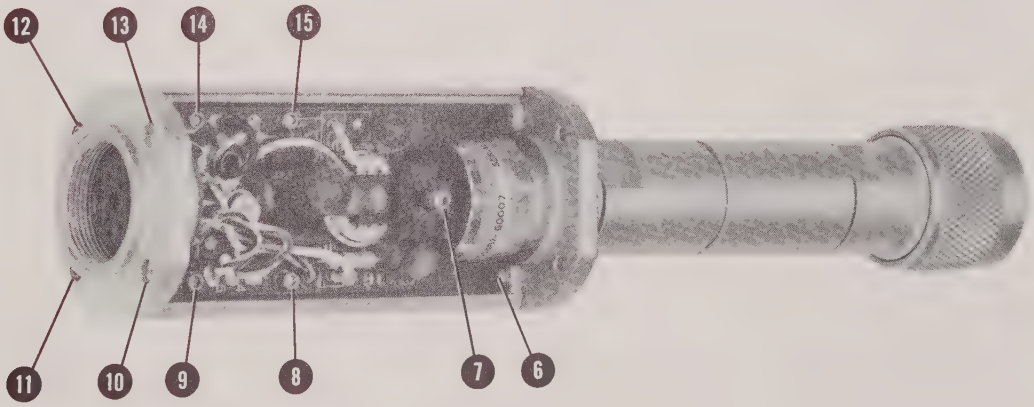


Figure 6. Power Sensor Hardware Locations

HP Part No. 08481-90016

Printed in U.S.A.

HEWLETT PACKARD

Operating
and
Service
Manual

HP 8481D
Power Sensor

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Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements in open setups, the user must ensure that under these operating conditions, the radio frequency interference limits are me at the border of his premises.

HP 8481D
POWER SENSOR

OPERATING AND SERVICE MANUAL

SERIAL NUMBERS

This manual supplement applies directly to instruments with serial numbers prefixed 2927A.
For additional important information about serial numbers, see "Instruments Covered by Manual".

HP Part No. 08481-90043

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Printed in USA

Figure 1. HP 8481D Power Sensor with HP 11708A Attenuator

General Information

This Operating and Service Manual contains information about initial inspection, operation, performance tests, troubleshooting and repair of the HP 8481D Power Sensor.

Instruments Covered by Manual

This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form a sequential suffix which is unique to each instrument. The contents of this manual apply directly to instruments having the serial number prefix listed under SERIAL NUMBERS on the title page.

Manual Changes Supplement

An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the manual for this instrument is supplied with a yellow Manual Changes supplement that documents the differences.

In addition to change information, the supplement may contain information for correcting errors in the manual. The supplement is keyed to the manual print date and part number, both of which appear on the title page of the Manual Change supplement.

For information concerning a serial number prefix not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett- Packard office.

Warranty

The Power Sensor is warranted and certified as indicated on the inside cover of this manual.

Description

The HP 8481D Power Sensor is a diode power sensor. It measures power levels in a range from −70 dBm to −20 dBm (100 pW to 10 μW) The HP 8481D measures at frequencies from 10 MHz to 18.0 GHz. (Specifications for the Power Sensor are in Table 1.)

The Power Sensor measures power dissipated in a 50Ω power sensor load placed on the source. The power dissipated in this 50Ω load is displayed on a compatible power meter in nW (or μW) and dBm.

Note

The HP 8481D Power Sensor is compatible with the HP 435B, HP 436A, HP 437B, HP 438A, and HP 70100A power meters. The HP 8481D Power Sensor cannot be used with the HP 435A Power Meter.

Calibration data is provided by a table on the Power Sensor. Further calibration data is also provided on a data sheet included with each Power Sensor. The calibration data, individually prepared for each Power Sensor, shows the calibration factor (CAL FACTOR) at selected frequencies from 10 MHz to 18 GHz.

Caution

The HP 8481D Power Sensor is extremely static sensitive. Do not open the Power Sensor unless you and the Power Sensor are at a static free work station.

Accessories

Included with each Power Sensor is the HP 11708A 30 dB Attenuator. To calibrate the HP 8481D, the 50 MHz 1 mW RF reference power supplied by the power meter must be reduced to 1 μW. The reference attenuator provides a means to do this.

Note

The HP 11708A 30 dB Attenuator is intended for use only at the 50 MHz POWER REF output of the power meter. Its usefulness as a calibration reference may be compromised if used for other purposes.

Specifications

The specifications listed in Table 1 are the performance standards or limits against which the Power Sensor may be tested.

Table 1. HP 8481D Specifications

Characteristics and Conditions	Limits	Comments
Frequency Range	10 MHz to 18 GHz	
Power Range	−70 dBm to −20 dBm (100 pW to 10 μW)	
Impedance	50 ohm	nominal
Connectors	Type N (Male)	
Maximum Standing Wave Ratio (SWR) and Reflection Coefficient (Rho)		
Frequency	SWR Rho	
10 MHz to 30 MHz	1.40 0.167	
30 MHz to 4 GHz	1.15 0.070	
4 GHz to 10 GHz	1.20 0.091	
10 GHz to 15 GHz	1.30 0.130	
15 GHz to 18 GHz	1.35 0.150	
HP 11708A	1.05 0.024	at 50 MHz
HP 11708A Accuracy	30 ±0.05 dBm	At 50 MHz and 25°C, NIST traceable, temperature coefficient 0.003 dB typ. per degree C.
Maximum Average Power	100 mW peak 100 mW average	
Worst Case Power Linearity		
100 pW to 1 μW	Negligible	−70 dBm to −30 dBm
1 μW to 10 μW	±2%	−30 dBm to −20 dBm
Operating Temperature	0 to 55°C	
Net Weight	0.14 kg (0.28 lb)	
Dimensions	length: 102 mm (4.03 in) Width: 38 mm (1.5 in) Height: 30 mm (1.19 in)	
HP 11708A	Length: 60 mm (2.4in) Diameter: 20 mm (0.79 in)	

Calibration Factor (CF) and Reflection Coefficient (Rho)

CF and Rho data at 2 GHz increments are provided on a label attached to the sensor cover. Calibration factor and Reflection coefficient data are given at 1 GHz increments on a data sheet included with the Power Sensor. This data is unique to each sensor. If you have two sensors, match the serial number on the data sheet with the serial number on the Power Sensor to avoid confusion. Maximum uncertainties of the CAL FACTOR data are listed in Table 2. The CAL FACTOR compensates for the frequency response of the sensors.

Reflection Coefficient (Rho, or ρ) relates to SWR according to the following formula:

$$SWR = (1+\rho)/(1-\rho)$$

Table 2. HP 8481D Calibration Factor Uncertainty at 1 μW

Frequency (GHz)	(RSS) Probable Uncertainty (%)
1.0 GHz	1.9%
2.0	1.8
4.0	1.8
6.0	1.8
8.0	2.0
10.0	2.2
12.0	2.8
14.0	3.2
16.0	3.4
18.0	3.7

Installation

Initial Inspection

Inspect the shipping container for damage. If the shipping container or packaging material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. If there is mechanical damage or if the instrument does not pass the performance tests, notify the nearest Hewlett-Packard office. Keep the damaged shipping materials (if any) for inspection by the carrier and a Hewlett-Packard representative.

ASSET # 2348

hp CALIBRATION REPORT

MODEL: 8481D
SERIAL No: 3318A12262
DATE: 22-JAN-1996
REF CAL FAC 100.0
TECHNICIAN: 360131

FREQUENCY MHz	EFFECTIVE EFFICIENCY %	CALIBRATION FACTOR %	REFLECTION at 24 deg C MAG	ANG
10.00	99.2	98.8	0.060	-72.0
300.00	99.9	99.9	0.014	-41.3
500.00	99.2	99.2	0.014	-60.7
1000.00	99.4	99.4	0.015	-113.7
2000.00	99.6	99.5	0.015	149.5
3000.00	98.8	98.8	0.010	73.9
4000.00	98.7	98.7	0.014	91.3
5000.00	98.5	98.4	0.027	25.0
6000.00	98.4	98.3	0.032	-58.7
7000.00	98.4	98.3	0.028	-159.6
8000.00	98.5	98.5	0.025	78.1
9000.00	98.4	98.3	0.027	-35.8
10000.00	98.4	98.3	0.026	-156.7
11000.00	98.8	98.7	0.034	71.8
12000.00	98.0	97.8	0.048	-33.2
12400.00	98.4	98.2	0.049	-69.8
13000.00	99.1	99.0	0.043	-122.4
14000.00	98.8	98.8	0.014	131.2
15000.00	98.8	98.8	0.030	-87.5
16000.00	99.6	99.2	0.057	174.0
17000.00	99.8	99.4	0.067	70.0
18000.00	99.6	99.0	0.073	-30.7

Interconnections

The HP 8481D Power Sensor has one input: a Type N male connector.

Refer to the power meter operating and service manual for interconnecting instructions.

Storage and Shipment

Environment

The instruments should be stored in a clean, dry environment. The following limitations apply to both storage and shipment:

Temperature	−55 to +75°C
Relative Humidity	< 95% at 40°C
Altitude	< 15,300 metres (50,000 feet)

Original Packaging

Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and serial number.

Table 3. Recommended Test Equipment

Instrument Type	Critical Specifications	Suggested Model	Use
Power Meter	No substitute	HP 435B	Adjustments
Digital Voltmeter	Input Impedance: 10 megohms Resolution: 10 μV Accuracy: ±0.05%, ±1 digit	HP 3478A	Troubleshooting and Adjustments
Oscilloscope	Bandwidth: dc to 50 MHz Vertical sensitivity: 0.2V/div Horizontal sensitivity: 1 ms/div	HP 54200A	Troubleshooting and Adjustments
10:1 Divider Probe	10 Megohms	HP 10004D	Troubleshooting
DC Power Supply	Range: 0 to 20V dc	HP 6200B	Troubleshooting

Operation

Warning

BEFORE CONNECTING THE POWER SENSOR TO OTHER INSTRUMENTS ensure that all instruments are connected to the protective (earth) ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

Operating Environment

The operating environment for the Power Sensor should be within the following limits:

Temperature	0° to 55°C
Relative humidity	< 95%
Altitude	< 4530 metres (15,000 feet)

Operating Precautions

If the following energy and power levels are exceeded, the power meter system may be damaged.

a. Maximum Average Power: 100 mW

b. Maximum Peak Power: 100 mW

c. Maximum Energy/Pulse: 10 W · μs

Maximum torque at the Type N connector should not exceed 8 lb-in (90 N-cm) to avoid damage to the connector.

Connect the Power Sensor by turning only the knurled portion of the connector. Damage can occur if torque is applied to the Power Sensor body.

The Type-N connector plastic insulator bead deteriorates when contacted by acetone, trichlorethylene, carbon tetrachloride, benzene, etc. Clean the connector face with a cotton swab saturated in isopropyl alcohol only.

Power Meter Calibrations

The procedure for calibrating one power meter may be different for another power meter. Follow the calibration directions given in your power meter manual.

Power Measurements

To correct for varying responses at different frequencies a cal factor chart is included on the Power Sensors. To use the cal factor at the frequency of interest, adjust the power meter's CAL FACTOR control according to the instructions in the power meter's operating and service manual. If you are using an HP 435B or HP 436A, the minimum cal factor setting is 85% and the maximum is 100%.

If the cal factor setting for your frequency of interest is below the meter's minimum or above the meter's maximum, set the cal factor control to 100%, and divide the reading in watts units (milliwatts or microwatts) by the decimal equivalent of the cal factor. For example, if the cal factor is 75%, divide the reading by 0.75. (This will result in a larger value of power than that displayed by the meter.) If the cal factor is 104% divide the reading by 1.04. (This will result in a smaller value of power than that displayed by the meter.)

Note

To calculate corrected dBm use the following formula:

Correction dB = Reading dB − (10 × Log_{10} Cal Factor decimal)

The sensitivity of the Power Sensor is influenced by ambient temperature. The sensor should be recalibrated at each change in temperature to obtain the most accurate results. Typical temperature sensitivity variations are shown in Figure 2.

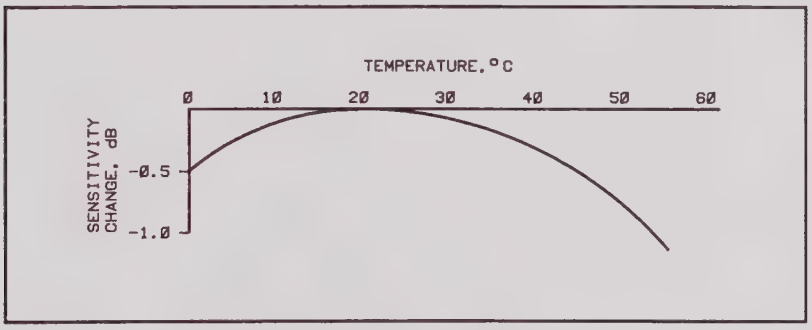

Figure 2. Typical Influence of Temperature on Sensitivity

Operating Instructions

To operate the Power Sensor, refer to the operating instructions in Section 3 of the power meter operating and service manual.

Modulation Effects

When measuring microwave sources that are modulated at the chopper frequency (nominally 220 Hz), or at the first or second harmonic or submultiples of the chopper frequency, beat notes will occur. Unless these beat notes are exactly the chopper frequency, they can usually be eliminated by averaging since the amplitudes are plus and minus the actual power. These frequencies may also be avoided by changing the modulation frequency slightly, if possible.

If you are using an HP 437B Power Meter select a manual filter setting of at least 128 averages (as displayed on power meter) to minimize beat note interference. To minimize beat note interference using an HP 438A Power Meter select a filter number of at least 7.

Standing Wave Ratio (SWR) and Reflection Coefficient (Rho) Performance Test

This section does not establish preset SWR test procedures since there are several test methods and different equipment available for testing the SWR or reflection coefficient. Therefore, the actual accuracy of the test equipment must be accounted for when measuring against instrument specifications to determine a pass or fail condition. The test system used must not exceed the system Rho uncertainties shown in Table 4.

To measure SWR from 10 MHz to 18 GHz,

Table 4. Power Sensor SWR and Reflection Coefficient

Frequency	System Rho Uncertainty	Actual Measurement	Maximum SWR (Rho)
10 MHz to 30 MHz	±0.0085	_____	0.167
30 MHz to 4 GHz	±0.0084	_____	0.070
4 to 10 GHz	±0.0087	_____	0.091
10 to 15 GHz	±0.0087	_____	0.130
15 to 18 GHz	±0.0087	_____	0.150

FET Balance Adjustment

Warning

The following procedure exposes high voltage areas within the power meter. Use extreme care while working around these areas or personal injury could occur.

Caution

Electrostatic discharge will render the Power Sensor inoperative. Do not open the Power Sensor unless you and the Power Sensor are at a static free work station.

Equipment

Oscilloscope	HP 54200A
Power Meter	HP 435B
Multimeter	HP 3478A

The sampling gate balance is affected by the relative positions of the wires in the Power Sensors, which connect to pins G and H of connector J1. One wire is black and white; the other is brown and white. Moving the black and white wire will adjust the switching transient amplitude (spike). Moving the brown and white wire will change the offset. Once positioned, care must be used not to displace these wires. To correctly position these wires, after replacement of A1 Bulkhead Assembly or A2 Input Amplifier Assembly, or if the wires have been moved so as to affect the sampling gate balance, perform the following procedure.

Note

If the Power Sensor printed circuit board A2 has been removed for repair, make sure all surfaces are thoroughly clean and free of flux residues before attempting the following adjustments.

1. Set the multimeter controls as follows:

FUNCTION	Voltage
RANGE	20 mV, full scale

2. Set oscilloscope controls as follows:

SENSITIVITY	0.2 V/DIV
SWEEP	1ms/DIV
TRIGGER	INT+
DISPLAY	A

3. Set the power meter CAL FACTOR to 100%. Set the power meter RANGE to 1 mW (0 dBm).
4. Open the Power Sensor (see Disassembly Procedure, Steps 1 through 3). Zero and calibrate the power meter. Leave the opened Power Sensor connected to the power meter POWER REF output. Heat can affect the adjustments so handle the sensor as little as possible.
5. Make sure the POWER REF switch on the rear panel of the power meter is in the OFF position.
6. Remove the HP 435B bottom panel. This will expose the circuit side of the A5 printed circuit board. On A5 you will see a long double row of soldered terminals numbered 1 to 44.
7. Connect a probe from pin 40 (the number 902 is printed on the board next to pin 40) to the multimeter input.
8. Lay the HP 435B on its left side and remove the right panel. This will expose the A4 assembly.
9. Connect a 1:1 probe from TP4 to channel A on the oscilloscope.
10. **Offset.** Read the multimeter and adjust the position of the brown and white wire until the reading is between -4.0 mV and +4.0 mV.

11. **Switching transients.** Read the oscilloscope and adjust position of the black and white wire until the switching transients are less than 0.8V peak to peak.

Note

The positioning of the wires is not an exact procedure. Each Power Sensor is slightly different. Generally, the brown and white wire will cross over the black and white wire at right angles. The black and white wire runs roughly parallel to the chassis. You will find that positioning the wire for switching transients affects the offset. Go back and forth between the two wires, positioning and repositioning, until both adjustments are within specifications.

Replaceable Parts

Table 5 is a list of replaceable parts. Figure 3 is the illustrated parts breakdown (IPB) that identifies the major locations of the components on the A2 Input Amplifier Assembly are shown in Figure 4. To order a part, quote the Hewlett-Packard part number and Check Digit (CD), specify the quantity required, and address the order to the nearest Hewlett-Packard office.

Note

Within the USA, it is better to order directly from the HP Parts Center in Roseville, California. Ask your nearest HP office for information and forms for the "Direct Mail Order System." Also your nearest HP office can supply toll free telephone numbers for ordering parts and supplies.

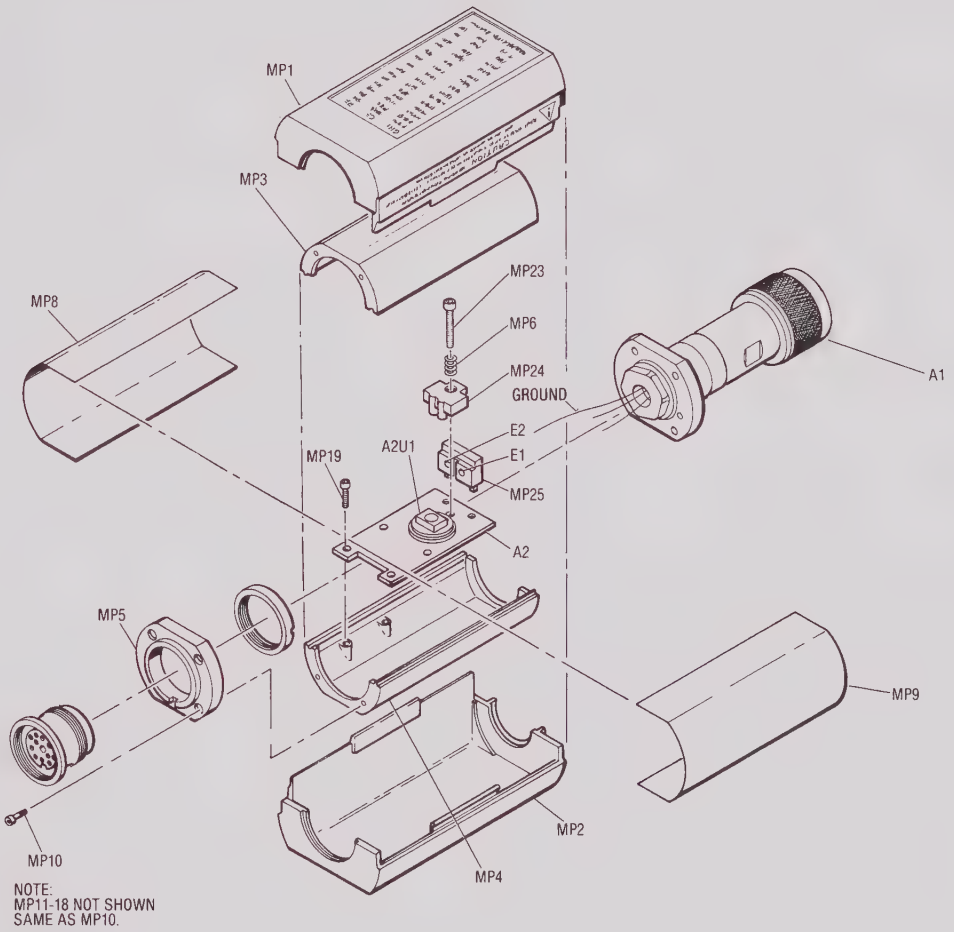

Figure 3. Illustrated Parts Breakdown

Table 5. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
A1	08481-60022	5	1	BULKHEAD ASSY	28480	08481-60022
A2	5061-0983	9	1	POWER SENSOR BOARD ASSY	28480	5061-0983
				A2 MISCELLANEOUS PARTS		
	0590-1040	1	1	THREADED INSERT-NUT 0-80 .06-IN-LG SST	46384	YC3-1505
	5040-6938	6	1	SPACER	28480	5040-6938
				CHASSIS PARTS		
MP1	5040-6998	8	2	SHELL-PLASTIC	28480	5040-6998
MP2	5040-6998	8		SHELL-PLASTIC	28480	5040-6998
MP3	08481-20011	8	2	CHASSIS	28480	08481-20011
MP4	08481-20011	8		CHASSIS	28480	08481-20011
MP5	08481-20008	3	1	END BELL	28480	08481-20008
MP6	1460-1978	0	1	SPRING-CPRSN .088-IN-OD .188-IN-OA-LG	84830	C1-012B-2-SS
MP8	08481-00002	5	2	SHIELD	28480	08481-00002
MP9	08481-00002	5		SHIELD	28480	08481-00002
MP19	3030-0422	8	4	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP20	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP21	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP22	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP10	3030-0954	1	9	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP11	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP12	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP13	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP14	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP15	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP16	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP17	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP18	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP23	3030-0436	4	1	SCREW-SKT HD CAP 0-80 .5-IN-LG SST-300	00000	ORDER BY DESCRIPTION
MP24	5040-6939	7	1	CLAMP	28480	5040-6939
MP25	5040-6940	0	1	BLOCK	28480	5040-6940
MP26	08481-80011	4	1	LABEL-IDENTIFICATION	28480	08481-80011
MP27	7121-2422	9	1	LABEL-CAUTION	28480	7121-2422
MP28	08486-80006	2	1	CAL-LABEL (BLANK)	28480	08486-80006
MP29	08481-80005	6	1	MYLAR TAPE (COVERS CAL LABEL)	28480	08481-80005
MP30	08486-80005	1	1	LABEL INFO (SIDE)	28480	08486-80005

Table 6. Code List of Manufacturers

Mfr. Code	Manufacturer Name	Address		Zip Code
00000	ANY SATISFACTORY SUPPLIER			
05876	U S POLYMERTIC INC			
28480	HEWLETT-PACKARD CO CORPORATE HQ	STAMFORD	CT	06904
46384	PENN ENGINEERING & MFG CORP	PALO ALTO	CA	94304
84830	LEE SPRING CO	DOYLESTOWN	PA	18901
		BROOKLYN	NY	11219

Service

Service instructions consist of principles of operation, troubleshooting, and repairs. Test equipment which meets or exceeds the critical specifications in Table 3 may be used in place of the recommended instruments for troubleshooting the Power Sensor.

Principles of Operation

Refer to the schematic Figure 5 and the operational amplifier diagram Figure 6 for the following explanation. The operational amplifier is made up of the Power Sensor input amplifier, A2Q1, and the first amplifier stage in the power meter.

The A1 Bulkhead Assembly provides a 50 ohm load to the rf signal applied to the Power Sensor. A diode assembly in the bulkhead rectifies the applied rf to produce a dc voltage which varies with the square of the rf power across the 50 ohm load. Thus the voltage varies with the rf power dissipated in the load. With maximum specified rf power (10 μW) the dc voltage is approximately 5mV.

This low level dc voltage is passed on gold wires through A2E1 and A2E2. A2E1 and A2E2 are ferrite beads which increase the inductance of the wires causing that portion of the wires to act as an rf choke. The result is to minimize rf feedthrough to the A2 input amplifier assembly.

The dc voltage from the bulkhead assembly must be amplified before it can be transferred on standard cables to the power meter. The amplification is provided by an input amplifier assembly which consists of a chopper (sampling gate) and an input amplifier. The chopper circuit converts the dc voltage to an ac voltage. To do this, the chopper uses two field effect transistors (FETs) in A2U1 controlled by a 220 Hz square wave generated by the power meter. The amplitude of the sampling gate output (at pin 3 of A2U1) is a 220 Hz square wave proportional to the power input. The sampled 220 Hz ac output is applied to the input ampifier A2Q1 which is the input for the first amplifier stage in the power meter. (Figure 6). The ac gain of the operational amplifier is approximately 1700.

Resistors A2R22, A2R23, A2R24, and A2R25 together with capacitor A2C11, thermistor A2RT3, and diode A2CR1, make up a shaping network. This network brings about a linear change in the amplitude of the square wave output as rf input power changes. A shaping network is necessary in the HP 8481D Diode Power Sensor to compensate for the characteristics of the thermocouple type shaping network in the power meter and to make minor diode corrections (Figure 6). In order to bring about a liner change in amplitude, A2R22, A2R23, and A2R25 are factory selected to match variations of the diode assembly in the bulkhead.

A dc feedback voltage from the power meter Auto Zero Chopper circuit is coupled to the input of FET A2U1Q1 to set the zero level. A2R21 is factory selected to match variation of the diode assembly in the bulkhead.

When the Power Sensor is used with a compatible power meter, the short to ground at J1-K (Mount Resistor) causes the power meter to automatically select the proper measurement range of −70 to −30 dBm.

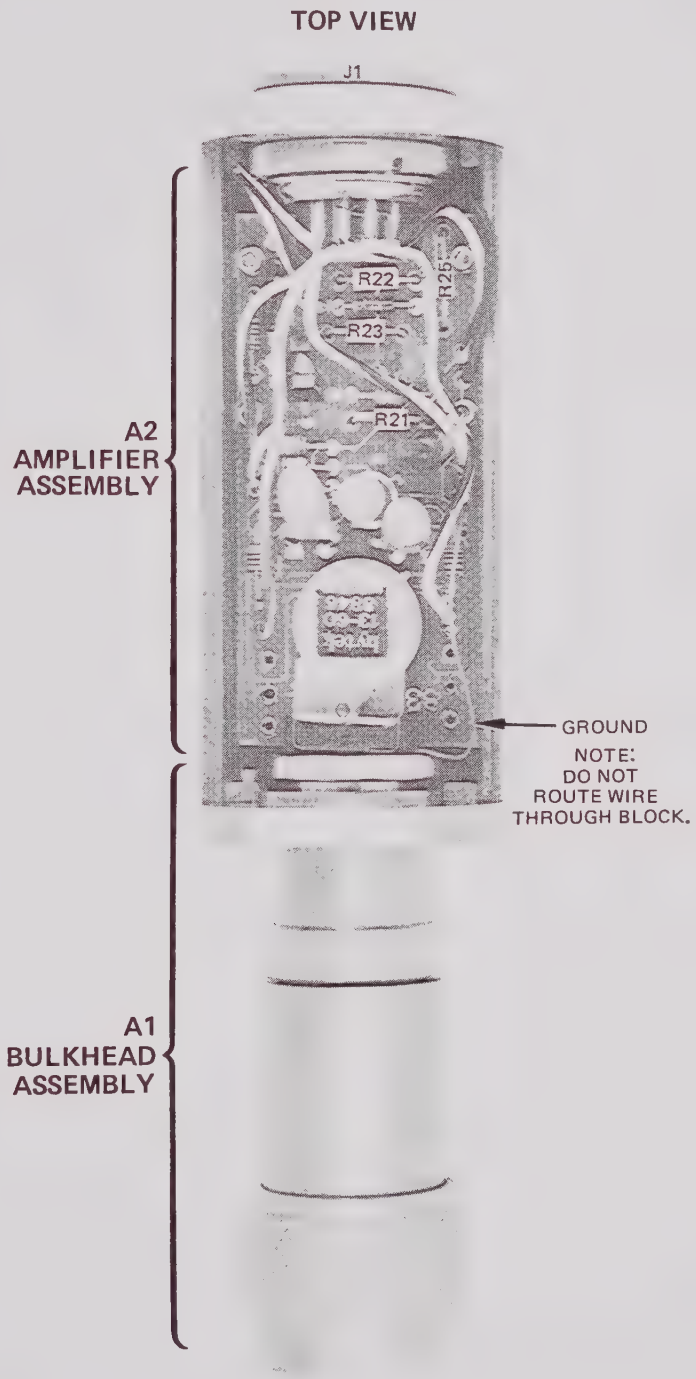

Figure 4. Component and Assembly Locations

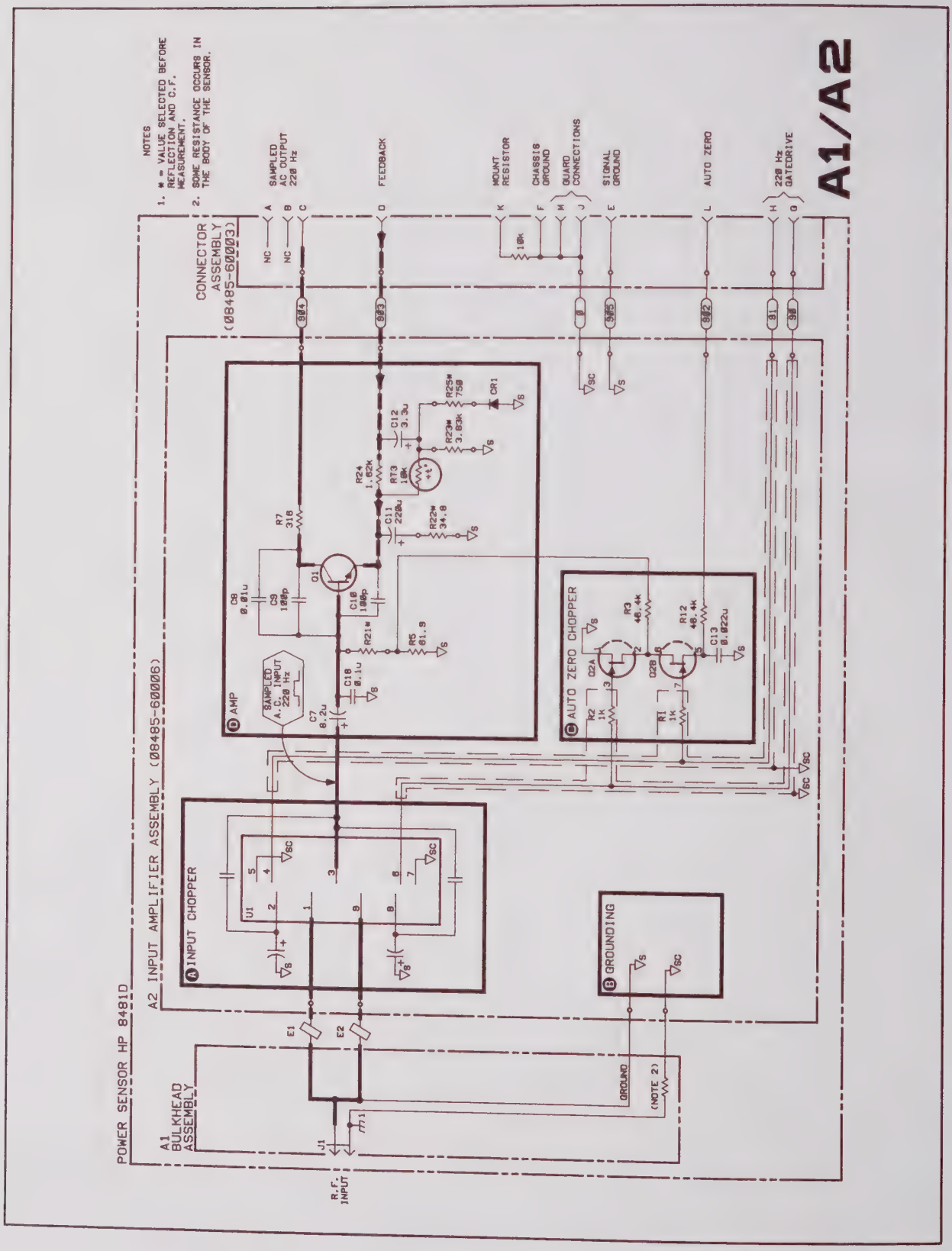

Figure 5. Power Sensor Schematic Diagram

Troubleshooting

Troubleshooting information is intended to first isolate the Power Sensor or power meter as the defective component. When the Power Sensor is isolated, troubleshooting information is intended to identify A1 Bulkhead Assembly or A2 Input Amplifier Assembly as the defective component.

Note

FETs in A2U1 are light sensitive and dc levels are shifted slightly when the FETs are exposed.

Caution

Electrostatic discharge will render the Power Sensor inoperative. Do not, under any circumstances, open the Power Sensor unless you and the power sensor are in a static free environment.

220 Hz Drive

To ensure the 220 Hz signal from the power meter is correct, check the following levels of the square wave with an oscilloscope.

1. At the white-black wire: -0.05 ± 0.05 Vdc (top of square wave).
2. At the white-brown wire: below -9.0 Vdc (bottom of square wave as indicated on display).

If the levels are correct the Power Sensor is at fault. Continue with troubleshooting the Bulkhead Assembly. If the levels are incorrect, the power meter is at fault. Refer to the power meter manual for troubleshooting information.

Bulkhead Assembly

A1 Bulkhead Assembly generates 0.9 mV to 1.5 mV when 1 μW is applied to the the input. If the voltage is incorrect, the bulkhead assembly is inoperative.

Caution

Disconnect the gold wires from the A2 assembly before measuring the resistance. Be extremely careful when measuring across the gold wires. They are delicate and can be damaged easily.

Detach the gold wires from the A2 assembly (step 4 Dissassembly Procedure). Place the HP 11708A between the 1 mW power reference of the power meter and the Power Sensor. Turn on the POWER REF switch of the power meter. Voltage measured across the two gold wires from the A1 assembly should be between 0.9 mV and 1.5 mV.

If the voltage is not correct, replace the A1 Bulkhead Assembly. If the voltage is correct, replace the A2 Assembly.

Operational Amplifier

In most cases, the operational amplifier (made up of A2Q1 and the first amplifier in the power meter, Figure 6) is operating correctly if the dc voltage on the metal cover of A2Q1 (collector) is -70 ± 30 mV dc.

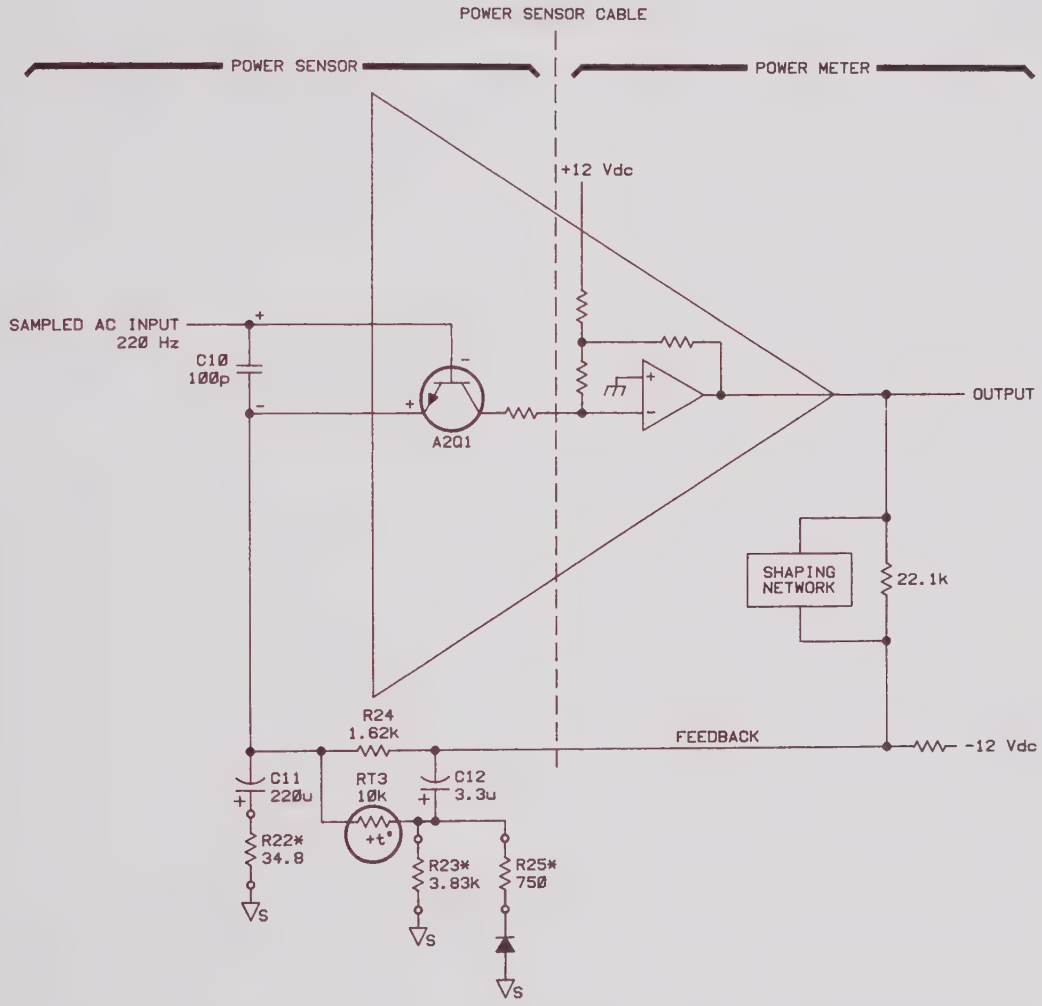

Figure 6. Operational Amplifier

Repair

Caution

Electrostatic discharge will render the Power Sensor inoperative. Perform repairs only at a static-free work station. You, the Power Sensor, and the soldering iron must be at the same static potential to avoid damage to the unit.

Soldering Procedures

The Power Sensor is a high sensitivity device, and is affected by very small differences in temperature between its components. Therefore, after doing any soldering in the unit, wait several hours for the unit to reach thermal equilibrium before using or testing it.

1. Use a temperature controlled 600°F (311°C) with a zero crossover tip.
2. Use a low temperature RMA flux, SN 62 solder.

A1 Bulkhead Assembly

There are no serviceable parts inside the A1 Bulkhead Assembly. If the bulkhead is defective, replace it with either a new or a restored bulkhead assembly (Table 5 Replaceable Parts). Each bulkhead replacement will come with selected resistors A2R21, A2R22, A2R23, and A2R25.

Replacement Procedure:

1. Remove the bulkhead assembly according to steps 1 through 7 in the disassembly procedure on the following page.
2. Remove and discard the socketed resistors A2R21, A2R22, A2R23, and A2R25 (Figure 4).
3. Replace the socketed resistors with the selected resistors which came with your replacement bulkhead.
4. Reassemble the Power Sensor according to steps 1 through 13 of the reassembly procedure (page 25).
5. Perform the FET balance adjustment (Page 10).
6. Reassemble the Power Sensor shields and shells.
7. Replace the CAL Factor label with the new label that came with your bulkhead assembly.

A2 Input Amplifier Assembly

There are no serviceable parts in the A2 Input Amplifier Printed Circuit Assembly. If you have determined A2 is faulty, replace it with the new or restored assembly listed in Table 5 Replaceable Parts.

Replacement Procedure:

1. Remove and label the socketed resistors A2R21, A2R22, A2R23, and A2R25.
2. Remove the A2 assembly according to the disassembly procedure on the following page.

3. Replace with a new A2 Assembly.
4. Replace the resistors into their proper sockets.
5. Clean flux residue thoroughly and perform the FET balance adjustment (Page 10).
6. Reassemble the Power Sensor according to the reassembly procedure steps 1 through 14 (page 24).

Cleaning

Caution

Do not handle the A2 input amplifier circuit board more than necessary. It is particularly important to keep the area around A2U1 clean. Dirt or moisture from the hands may make circuits inoperative.

Cleaning Solutions

Keeping in mind its flammable nature, a solution of pure isopropyl or ethyl alcohol can be used to clean printed circuits and connectors.

Connector Cleaning

Caution

The RF connector bead inside the calibration adapter deteriorates when contacted by hydrocarbon compounds such as acetone, trichlorethylene, carbon tetrachloride, and benzene.

Clean the connector only at a static free work station. Electrostatic discharge to the center pin of the connector will render the Power Sensor inoperative.

Clean the connector face using a cotton swab dipped in isopropyl alcohol. If the swab is too big use a round wooden toothpick wrapped in a lint free cotton cloth dipped in isopropyl alcohol.

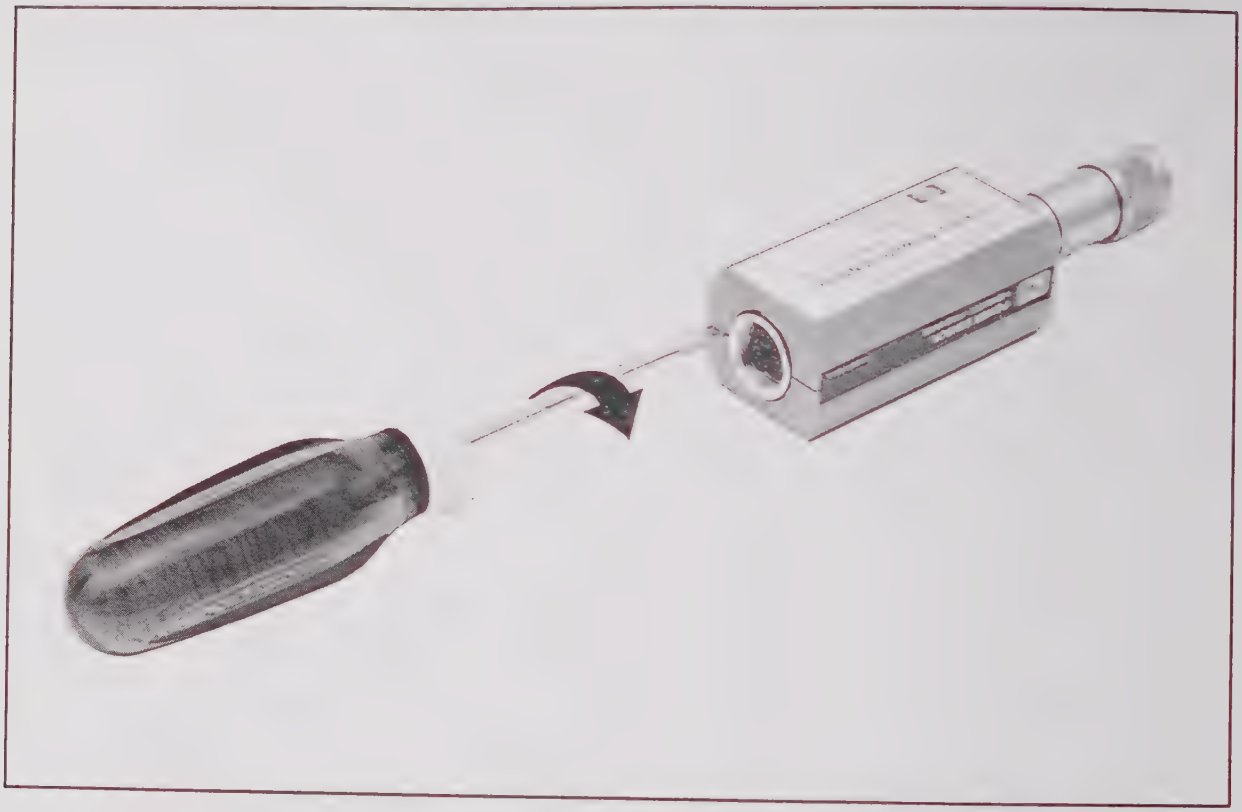

Figure 7. Removing Power Sensor Shell

Disassembly Procedure

Disassemble the Power Sensor by performing the following steps:

Caution

Disassembly must be performed in the sequence described below, otherwise damage may be caused to the two gold wires between the bulkhead assembly and the input amplifier assembly. If these wires are damaged, the A1 Bulkhead Assembly must be replaced.

Disassemble the Power Sensor only in a static free work station. Electrostatic discharge will render the Power Sensor inoperative.

Note

Every Power Sensor has an individually prepared table on the housing. If more than one power sensor is disassembled at a time, be sure to mate the correct Power Sensor and housing when reassembling.

1. At rear of Power Sensor, insert the blade of a screwdriver between the plastic shells (Figure 7). To prevent damage to the plastic shells use a screwdriver blade as wide as the slot between the two shells.
2. Pry alternately at both sided of connector J1 until the plastic shells are apart. Remove shells and magnetic shields.

3. Position the Power Sensor as shown in Figure 8, top view so that the small hole **(5)** is on the left side of the rf input connector. Remove allen cap screws **(1)**, **(2)**, **(10)**, and **(13)**. Loosen screws **(11)**, and **(12)**. Remove the upper chassis from the Power Sensor.
4. Remove clamp screw **(6)** together with screw spring and clamp **(16)**. This will free the two gold wires that come from the bulkhead assembly.
5. Remove cap screws **(7)**, **(3)**, and **(4)**.
6. Desolder the brown wire that originates at the bulkhead and terminates in A2.
7. Slide bulkhead assembly straight out from the chassis.
8. If A2 Input Amplifier Assembly must be removed then remove cap screws **(8)**, **(9)**, **(11)**, **(12)**, **(14)**, and **(15)**.
9. Lift input amplifier and J1 connector out of the chassis.

Reassembly Procedure

Use the following procedure to assemble the Power Sensor.

Caution

The two gold wires connecting the A1 Bulkhead Assembly and the A2 Input Amplifier Assembly are extremely delicate and may be easily broken. Be careful when working around them.

1. Set printed circuit board and connector into place as shown in Figure 8, bottom view.
2. Insert cap screw **(8)**, **(9)**, **(11)**, **(12)**, **(14)**, and **(15)** but do not tighten.
3. Center A2 circuit board so there is an equal air gap between each side and chassis. Tighten cap screws **(8)**, **(9)**, **(14)**, and **(15)**.
4. Remove the black plastic block **(17)** from the printed circuit board. Position the bulkhead assembly with the small hole **(5)** on your left; position block **(17)** with the flat side towards the bulkhead assembly (grooved side out), and guide pins down. Insert the gold wires through the holes in the block **(17)** (MP25, Figure 3).
5. Set the bulkhead assembly straight down on the chassis. Mate the two guide pins on the block **(17)** with the two holes in the printed circuit board (Figure 3.)
6. Resolder the brown wire into the printed circuit board.

Note

The gold wires will lay on or near the electrical gold pads at input to FET A2U1.

7. Insert screws **(3)** and **(4)** and tighten.

8. Using tweezers, position (adjust) the gold wires over the electrical pads.

Caution

DO NOT tighten clamp screw (**6**) excessively or the FET circuit may be broken.

9. Place and hold plastic clamp (**16**) over the gold wires. (Ensure that the wires have not moved from the position set in step 7.) As you tighten the clamp screw, watch the compression spring. Tighten clamp screw (**6**) only until the spring coils touch. Any further tightening could damage the FET circuit.

   If you cannot obtain a good contact, repeat steps 8 and 9 above and continue with the following procedure.

10. Loosen screws (**3**) and (**4**). Insert screw (**6**) and tighten.
11. Place upper chassis in position and insert cap screws (**1**), (**2**), (**10**), and (**13**).
12. Tighten screws (**1**), (**2**), (**3**), and (**4**).
13. Tighten screw (**10**), (**11**), (**12**), and (**13**).
14. Replace magnetic shields and plastic shells as shown in Figure 3. Snap plastic shells together.

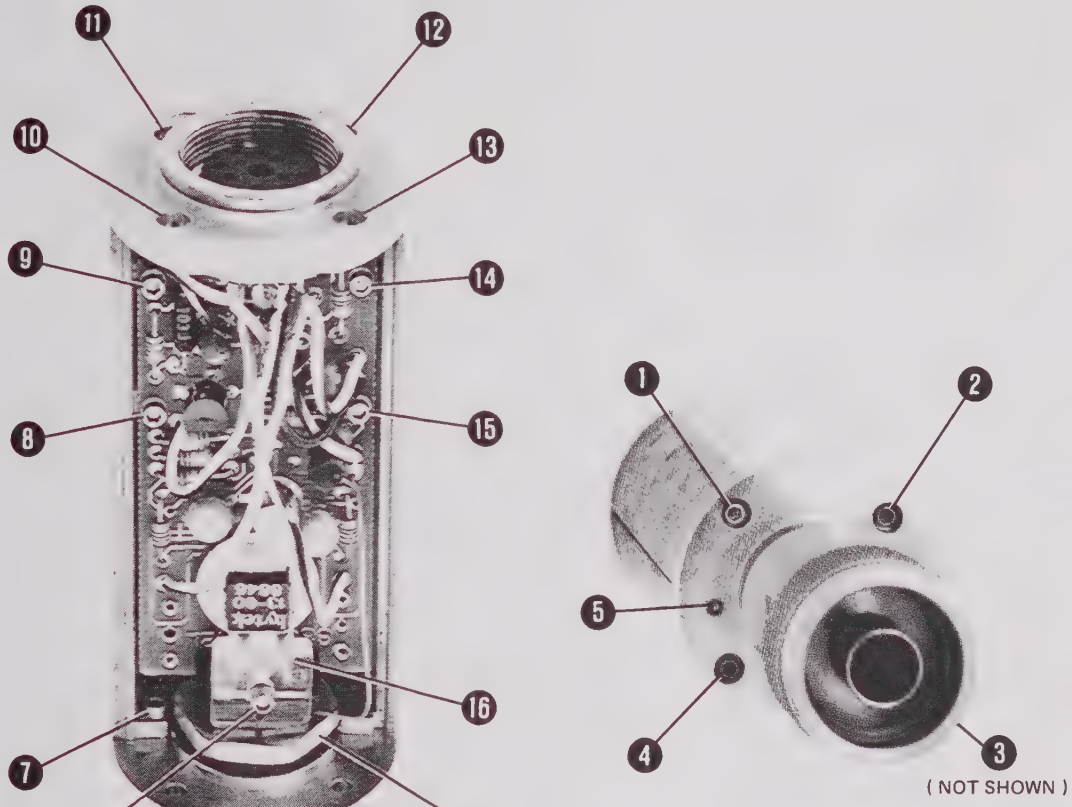

Figure 8. Power Sensor Hardware Locations

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